# The Pain and Movement Reasoning Model:

# Exploring utility and suitability

Lester E. Jones

BBSc, BAppBSc(Physio), MScMed (PainMgt)

A thesis submitted in total fulfillment of the requirement

for the degree of Doctor of Philosophy

Judith Lumley Centre

School of Nursing and Midwifery

College of Science, Health and Engineering

La Trobe University

Victoria, Australia

This work was supported by an Australian Government Research Training Program

Scholarship

December 2020

# Table of Contents

Abstract ..... i

Statement of authorship ..... ii

Acknowledgements ..... iii

List of Tables ..... iv

List of Figures ..... v

Abbreviations ..... vi

Research dissemination ..... vii

Structure of thesis ..... xiv

Chapter 1 – Introduction ..... 1

1.1 From the gate to the neuromatrix ..... 1

1.2 Reasoning processes and characteristics ..... 10

1.3 The Pain and Movement Reasoning Model ..... 15

1.4 Aims and scope of thesis ..... 19

1.5 Researcher context ..... 20

1.6 References ..... 23

Chapter 2 – Stress, pain and recovery ..... 31

2.1 Introduction to published work ..... 31

2.2 Contributions ..... 32

2.3 Published work ..... 32

2.4 Related publications ..... 62

2.5 Concluding comments ..... 62

2.6 References ..... 63

Chapter 3 – Meaning of pain and the social context ..... 64

3.1 Introduction to published work ..... 64

3.2 The book ..... 65

3.3 Contributions ..... 66

3.4 Published work ..... 66
3.5 Related publications ..... 87
3.6 Concluding comments ..... 87
3.7 References ..... 88
Chapter 4 – Methods ..... 90
4.1 Beyond information giving ..... 90
4.2 Description of methods ..... 95
4.3 Patient perceptions of person-centred care ..... 110
4.4 Ethics review and local governance ..... 112
4.5 References ..... 113
Chapter 5 – Improving pain literacy ..... 119
5.1 Introduction to submitted work ..... 119
5.2 Additional comment on methods ..... 120
5.3 Contributions ..... 122
5.4 Submitted work (*redacted*) ..... 123
5.5 Related publications and presentations ..... 155
5.6 Concluding comments ..... 157
5.7 References ..... 157
Chapter 6 – Suitability and utility of the Model ..... 159
6.1 Introduction to submitted work ..... 159
6.2 Additional comment on methods ..... 160
6.3 Contributions ..... 163
6.4 Submitted work (*redacted*) ..... 164
6.5 Related publications and presentations ..... 216
6.6 Concluding comments ..... 216
6.7 References ..... 217

Chapter 7 – Beyond physiotherapy ..... 218
7.1 Introduction ..... 218
7.2 Contributions ..... 219
7.3 Published work ..... 219
7.4 Related publications and presentations ..... 226
7.5 Concluding comments ..... 228
7.6 References ..... 228
Chapter 8 – Discussion ..... 230
8.1 Changing contexts: pain concepts and Australian physiotherapy ..... 231
8.2 Learnings from the research project ..... 235
8.3 Strengths and limitations ..... 240
8.4 Contribution to new knowledge ..... 243
8.5 Future research ..... 245
8.6 Concluding comments ..... 248
8.7 References ..... 250
Appendix A: Ethics approval for the doctoral research project ..... 254
Appendix B: Participant information and consent forms ..... 264
Appendix C: Questionnaire used in the doctoral research project ..... 279
Appendix D: Education intervention used in the doctoral research project ..... 289
Appendix E: Focus group and interview guide ..... 310
Appendix F: Codebook used in the doctoral research project ..... 313
Appendix G: Permissions for reproducing publications and figures ..... 321

# Abstract

Background

Pain is more than an indicator of tissue health and is described, in Neuromatrix Theory, as an output of complex neural processing involving three domains: cognitive, emotional and sensory. Other outputs include stress regulation and evasive and protective movement strategies. The Pain and Movement Reasoning Model is a clinical reasoning tool informed by Neuromatrix Theory. It is designed to help physiotherapists capture the complexity of pain using three mechanism-derived categories: local stimulation, regional influences and central modulation. The Model is used in clinical and education settings but, until now, has not been formally evaluated.

Methods

An education intervention was designed to be delivered in the workplace. Its purpose was to introduce contemporary concepts of pain, and the Model, and to support the use of the Model across different areas of physiotherapy. A definition of pain literacy was proposed and operationalised by measures of biopsychosocial attitudes and beliefs to pain, pain knowledge, person-centeredness and ability to apply pain concepts into practice. A mixed methods design was used to explore the impact of the intervention on pain literacy in physiotherapists and to determine the suitability and utility of the Model.

Results

The education intervention reduced the biomedical attitudes and beliefs of physiotherapists and improved pain knowledge. The Model was found to be suitable in different physiotherapy contexts and adapted versions of the Model are considered relevant and useful for application beyond physiotherapy.

Conclusion

An approach to pain education, that was brief in duration and situated in the workplace, was successfully delivered and well received. There is support for the use of the Pain and Movement Reasoning Model in education and clinical practice, across clinical areas and including disciplines other than physiotherapy. Importantly, there is value to both those new to applying pain concepts, and to those with experience and expertise.

# Statement of authorship

All work in this thesis was undertaken by myself, under the guidance of my supervisors, Professor Lisa Amir, Judith Lumley Centre, La Trobe University and Professor Stephen Kent, School of Public Health and Psychology, La Trobe University. Supervision was also provided by Professor Rhonda Small, prior to her retirement.

The thesis includes three publications and two submitted papers. I am the sole author of one book chapter, the second author of a second book chapter, the second author of a peer-reviewed article and the first author of two papers submitted to peer-reviewed journals. Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere, or extracted in whole or in part from a thesis accepted for the award of any other degree or diploma. No other person's work has been used without due acknowledgment in the main text of the thesis. This thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

This research received funding from the Social Research Assistance Platform, La Trobe University and support from the Statistics Consultancy Platform, La Trobe University. All research procedures in the doctoral project were approved by the relevant institutional ethics and governance committees.

Signed:

Lester Jones

Date: 01 October 2020

# Acknowledgements

First, thanks to all the participants and to the site co-ordinators for generously contributing their time to this project, and to La Trobe University Social Research Assistance Platform for financial support. This is how research happens.

To my first principal supervisor, Professor Rhonda Small, thanks for always welcoming my ideas and giving me early direction. To Professor Lisa Amir, who generously took over when Rhonda retired, thanks for being interested enough in my work to support and include me in your own work, and for all the guidance you have provided. To Professor Stephen Kent, thanks for being so receptive to my cold call; I knew I needed some different expertise and you provided exactly what was required.

Warm thanks to everyone I shared time with at the *Judith Lumley Centre* – such a collegiate and productive culture – and doing such great work. In particular, thanks to Dr. Laura Whitburn; it feels like we have been on a quite a journey now and I am so proud of the work we have achieved and continue to produce. Thanks for your energy.

From my clinical work, I would like to acknowledge all the people who have shared their stories of pain, their challenges and successes; especially the clients from Foundation House who continue to inspire me daily. I would also like to acknowledge the clinicians and leaders – too many to mention – who helped shape and support my way of thinking and practicing. Special thanks to Des O'Shaughnessy, Jazmin Cruz, Nick Economos, Anjelo Ratnachandra, Adam De Gruchy, Martina Moog and Alastair Flett for your generosity, intellectual curiousity and friendship.

It would be remiss of me not to acknowledge my *accountability* team: Ong Peck Hoon, Maxine Te and Bijaya Pokharel. Thanks for your company and keeping me on track. And to Kelly Spiteri, Meryl Lai Kong ling, July Lies, Dawn Wong Lit Wan, Jamuna Parajuli and Dieu Nguyen, thanks for your ongoing influence through examples of brilliance and humility. Your compassionate ways make the world a better place.

Lastly, and my biggest thanks to the lovely Ingrid (Ping, MOOK, Cobber Wilson) and Neneh and Soraya, for all your patience with me, for celebrating the wins along the way and for sharing this amazing life. Looking forward to what comes next.

# List of Tables


Table 4.1 Timepoints for data collection …….. 94

Table 4.2 Sample size calculation for PABS-PT Behavioural subscale …….. 101

Table 4.3 Sample size calculation for PABS-PT Biomedical subscale ……. 101

Table 4.4 Key references and video attributions for Online Resource 1 ……. 105

Table 5.1 Presentations of Pain and Movement Reasoning Model ……. 154

Table 6.1 Type of Practice and Clinical Areas of participants across recruitment sites ……. 159

Table 6.2 Type of Practice and Clinical Areas of participants: qualitative subset and total …….. 160

# List of Figures


Figure 1.1 The evolution of the gate control theory …… 4

Figure 1.2 Influences on pain perception …….. 7

Figure 1.3 Des' Pyramids …… 16

Figure 1.4 Early draft of Pain and Movement Reasoning Model …….. 17

Figure 4.1 Blended learning process incorporating concepts from reflective practice, flipped classroom approach and situational learning …… 92

Figure 5.1 Pain and Movement Reasoning Model ……..… 118

Figure 6.1 Pain and Movement Reasoning Model ……..… 158

# Abbreviations

| | |
|---|---|
| APA | Australian Physiotherapy Association |
| IASP | International Association for the Study of Pain |
| ICF | International Classification of Function, Disability and Health |
| NPQ-R | Neurophysiology of Pain Questionnaire (revised) |
| PABS-PT | Pain Attitudes and Beliefs Scale for Physiotherapists |
| PICF | Patient information and consent form |
| PPOS | Patient Practitioner Orientation Scale |
| WCPT | World Confederation of Physical Therapy<br>(also known as *World Physiotherapy*) |

# Research dissemination

## Publications

The following is a list of relevant publications completed during my candidature including those reproduced in this thesis (indicated by *). It also includes two papers completed prior to my candidature which significantly framed the ideas presented in this work.

| Year | Publication type | Title | Citations<br>Web of Science<br>01 Oct 2020 |
|---|---|---|---|
| 2014 | Peer Reviewed Publication | **Jones, L.E.** & O'Shaughnessy, D.P. (2014). The pain and movement reasoning model: introduction to a simple tool for integrated pain assessment. *Manual Therapy*, 19(3), 270-276. | 11 |
| 2014 | Peer Reviewed Publication | Whitburn, L.Y., **Jones, L.E.**, Small, R. & Davey, M-A (2014). Women's experiences of labour pain and the role of the mind: an exploratory study. *Midwifery*, 30(9),1029-1035. | 24 |
| 2015 | Peer Reviewed Publication<br>**(see Chapter 7)** | *Amir, L.H., **Jones, L.E.** & Buck, M.L. (2015). Nipple pain associated with breastfeeding: incorporating current neurophysiology into clinical reasoning. *Australian Family Physician* 44(3), 127-132. | 13 |
| 2015 | Peer Reviewed Publication | **Jones, L.E.**, Whitburn, L.Y., Davey, M-A. & Small, R. (2015). Assessment of pain associated with childbirth: women's perspectives, preferences and solutions. *Midwifery*, 31(7), 708-712. | 10 |
| 2016 | Professional Publication | De Gruchy, A. & **Jones, L.E.** (2016). Back pain: Grouping and clinical practice. *InTouch*, 3, 11-14. | |
| 2016 | Chapter in Edited Book | **Jones, L.E.** (2016). Beyond information giving: Subject design for enhancing reflection. In A. Peterkin & P. Brett-MacLean (Eds.), *Keeping Reflection Fresh,* pp. 363-367. Kent, Ohio: Kent State University Press. | |
| 2017 | Chapter in Edited Book<br>***(see Chapter 2)*** | ***Jones, L.E.** (2017). Stress, pain and recovery: Neuro-immune-endocrine interactions and clinical practice. In S. B. Porter (Ed.), *Psychologically Informed Physiotherapy: Embedding Psychosocial Perspectives Within Clinical Management,* pp. 78-106. Edinburgh, UK: Elsevier. | |
| 2017 | Letter to Editor | **Jones, L.E.**, Whitburn, L. Y., Davey, M. A., & Small, R. (2016). Numeric scoring of pain still has value. *Annals of Emergency Medicine*, 67(5), 679-680. | 3 |
| 2017 | Peer Reviewed Publication | Lies, J., Lau, S. T., **Jones, L.E.**, Jensen, M. P., & Tan, G. (2017). Predictors and moderators of Post-traumatic Stress Disorder: An investigation of anxiety sensitivity and resilience in individuals with chronic pain. *Annals of the Academy of Medicine*, Singapore, 46(3), 102-110. | 1 |

| Year | Publication Type | Title | Citations<br>Web of Science<br>01 Oct 2020 |
|---|---|---|---|
| 2017 | Peer Reviewed Publication | Whitburn, L. Y., **Jones, L.E.**, Davey, M. A., & Small, R. (2017). The meaning of labour pain: how the social environment and other contextual factors shape women's experiences. *BMC Pregnancy and Childbirth*, 17, 157. https://doi.org/10.1186/s12884-017-1343-3 | 15 |
| 2017 | Letter to Editor | Whitburn, L. Y., **Jones, L.E.**, Davey, M. A., & Small, R. (2017). Supporting the updated definition of pain. But what about labour pain? *Pain*, 158(5), 990-991. | 4 |
| 2018 | Peer Reviewed Publication | Holliday, S., Hayes, C., Jones, L.E., Gordon, J, Harris, N., Nicholas, M. (2018). Prescribing wellness: comprehensive pain management outside specialist services. Australian Prescriber, 41, 86-91. https://doi.org/10.18773/austprescr.2018.023 | 2 |
| 2018 | Peer Reviewed Publication | Uritani, D., Nishida, T., Sakaguchi, N., Kawakami, T., **Jones, L.E.** and Kirita, T. (2018). Difference in response to a motor imagery task: a comparison between individuals with and without painful temporomandibular disorders, *Pain Research and Management*, https://doi.org/10.1155/2018/6810412. | 3 |
| 2018 | Peer Reviewed Publication | Whitburn, L.Y., **Jones, L.E.**, Davey, M-A. and McDonald, S. (2019). The nature of labour pain: An updated review of the literature. *Women and Birth*, 32(1), 28-38. | 10 |
| 2019 | Peer Reviewed Publication | Amris K., **Jones, L.E.**, & Williams, A.C.d.C. (2019). Pain from torture: assessment and management. *Pain Reports*, 4(6), e794. | |
| 2019 | Peer Reviewed Publication | Lies, J., Jones, L.E., & Ho, R. (2019). The management of post-traumatic stress disorder and associated pain and sleep disturbance in refugees. *BJPsych Advances*, 25(3), 196-206. https://doi.org/10.1192/bja.2019.7 | 0 |
| 2019 | Chapter in Edited Book<br>***(see Chapter 3)*** | *Whitburn, L. Y., & Jones, L. E. (2019). Labour pain. In S. van Rysewyk (Ed.), Meanings of Pain (Vol. 2), pp. 143-162. Springer. https://doi.org/10.1007/978-3-030-24154-4_8 | |
| 2020 | Peer Reviewed Publication | Holliday, S., Hayes, C., **Jones, L.E.**, Gordon, J., Fraser, C., Harris, N., Nicholas, M., Holder, C., Oldmeadow, C. & Magin, P. (2020) Prescribers or multidisciplinarians? An evaluation of brief education for General Practitioners on chronic pain management. *Health Education in Practice, 3(1), http://dx.doi.org/10.33966/hepj.3.1.14146* | |
| 2020 | Peer Reviewed Publication | Whitburn, L.Y. & **Jones, L.E.** (2020). Looking for meaning in labour pain: Are current pain measurement tools adequate? *Pain Medicine,* Advance online publication https://doi.org/10.1093/pm/pnaa380 | |
| 2020 | Chapter in Edited Book | O'Shaughnessy, D.F.P., & **Jones, L.E.** (2020). Making sense of pain in sports physiotherapy: Applying the Pain and Movement Reasoning Model. In S. B. Porter & J. Wilson (Eds.), A Comprehensive Guide to Sports Physiology and Injury Management, Elsevier. | |

| Year | Publication Type | Title | Citations<br>Web of Science<br>01 Oct 2020 |
|---|---|---|---|
| 2020 | Chapter in Edited Book | Amris, K., **Jones, L.E.**, & Williams A.C.d.C. (in press). Treating pain after torture. In J. Modvig & M. Evans (Eds.), *Research Handbook on Torture* Edward Elgar Publishing. | |
| 2020 | Peer Reviewed Publication<br>***(see Chapter 5)*** | ***Jones, L.E.**, Heng, H., Heywood, S., Kent, S. & Amir L.H. (submitted). Improving pain literacy in the workplace using the Pain and Movement Reasoning Model: A mixed methods study of physiotherapists. | |
| 2020 | Peer Reviewed Publication<br>***(see Chapter 6)*** | ***Jones, L.E.**, Heng, H., Heywood, S., Kent, S. & Amir, L.H. (under review). The suitability and utility of the Pain and Movement Reasoning Model for physiotherapy: A qualitative study. | |

## Presentations

The following is a list of relevant presentations delivered during my candidature.

| Year | Presentation Type | Title |
|---|---|---|
| 2014 | Professional Presentation | Jones L.E. & Block, M. (2014) Pain and Trauma (presentation/workshop). Western Region Health Centre, Melbourne, Australia. |
| 2014 | Conference Workshop | Sherburn, M., Jones, L.E., & Sheat, R. (2014) Pelvic pain: developing a tool to enhance education and assist clinical reasoning (workshop). *Joint meeting of the Continence Foundation of Australia, International Children's Continence Society and the Urogynaecological Society of Australasia,* Cairns, Australia. |
| 2014 | Professional Workshop | Jones, L.E. (2014) Pain and trauma. Exploring chronic pain for nurses and allied health professionals (workshop). Victorian Foundation for Survivors of Torture, Melbourne, Australia. |
| 2014 | Conference presentation | Jones L.E. (2014) Education Resources. *Physiotherapy Preconference Workshop*, *Australian Pain Society Annual Scientific Meeting*, Hobart Australia. |
| 2015 | Conference Presentation | Block, M., Carlon, P., Dang McDonald, K., Jones L.E. & Martinez Cruz M. (2015) Branching Out: Exploring innovative ways to support refugees and asylum seekers experiencing pain (presentation). *International Conference on Migration, Social Disadvantage and Health.* Melbourne, Australia. |
| 2015 | Conference Presentation | Truong, D., Block, M. & Jones, L.E. (2015) IPET: An interactive pain education tool to explore chronic pain with people of low-literacy, refugee backgrounds (poster). *International Conference on Migration, Social Disadvantage and Health,* Melbourne, Australia. |
| 2015 | Conference Presentation | Jones, L.E., Block, M. (2015) Pain and Movement Reasoning Model: A tool for educating health and social care professionals about the multiple influences and determinants of pain in survivors of torture and trauma (presentation). *International Conference on Migration, Social Disadvantage and Health.* Melbourne, Australia. |
| 2015 | Conference presentation | Amir, L.H., Jones, L.E. & Buck, M.L. (2015) Breast and nipple pain associated with breastfeeding: A simple tool to capture the complexity of influences and determinants of pain (presentation/workshop). *Lactation Consultants Australia and New Zealand*, Brisbane, Australia. |
| 2015 | Conference Presentation | Jones, L.E., Block, M., Gardiner, J. & Truong, D. (2015) A safe body and a safe mind: how best to meet the needs of survivors of torture and trauma experiencing pain? (presentation) *Australian Pain Society 35th Annual Scientific Meeting*, Brisbane, Australia. |
| 2015 | Conference Presentation | Amir, L.H.. & Jones, L.E. (2015) Nipple pain during breastfeeding: A new model to improve diagnosis and management (presentation). GP15 Royal Australian College of General Practitioners Annual Scientific Meeting, Melbourne Conference and Exhibition Centre, Melbourne, Australia. |
| 2015 | Conference Presentation | Jones, L.E. & Wilson, D. (2015) The Pain and Movement Reasoning Model (presentation). GP15 Royal Australian College of General Practitioners Annual Scientific Meeting, Melbourne Conference and Exhibition Centre, Melbourne, Australia. |

| Year | Presentation Type | Title |
|---|---|---|
| 2015 | Professional Presentation | Jones, L.E. (2015) Understanding pain: Chronic danger and other contributions to the pain experience of survivors of torture (presentation). Victorian Foundation for the Survivors of Torture (Foundation House), Melbourne, Australia. |
| 2015 | Conference presentation | Jones, L.E. (2015) Evidence-based approach to skill development: a case study from physiotherapy (poster). World Confederation of Physical Therapy Congress, Singapore. |
| 2015 | Professional Presentation | Jones, L.E. (2015) Pain & Movement Reasoning Model (presentation/workshop). Department of Rehabilitation, Raffles Hospital, Singapore. |
| 2015 | Professional Presentation | Jones, L.E. (2015) The Pain and Movement Reasoning Model: Covering all the angles (presentation). Australian Physiotherapy Association Victorian Branch Winter Breakfast, Caulfield Racecourse, Melbourne, Australia. |
| 2015 | Professional Workshop | Jones, L.E. & Block, M. (2015) Pain Self Management Forum (workshop). HealthWest & Cohealth, Maribyrnong Town Hall, Maribyrnong, Melbourne, Australia. |
| 2016 | Professional Presentation | Jones, L.E. (2016) Feeling safe in the emergency department: Some concepts that might apply (presentation). Australian Physiotherapy Association Emergency Department and Pain Group, Melbourne, Australia. |
| 2016 | Professional Presentation | Jones, L.E. (2016) The Pain and Movement Reasoning Model: Covering all the angles (presentation). Australian Physiotherapy Association New South Wales Branch Dinner, Sydney, Australia. |
| 2016 | Professional Presentation | Jones, L.E. & Plante, A-F. (2016) Pelvic Pain Reasoning Model for women (presentation). Pelvic Pain Victoria, Royal Automobile Club of Victoria, Melbourne, Australia. |
| 2016 | Professional Presentation | Jones, L.E. (2016) Pain and Movement Reasoning Model (presentation/workshop), Wimbledon Clinics, Wimbledon, UK. |
| 2017 | Professional Presentation | Jones, L.E. (2017) Pain and Movement Reasoning Model: Integrating neuro-immune-endocrine interactions into clinical reasoning (presentation). Hong Kong Physiotherapy Association, Hong Kong, China. |
| 2017 | Professional Workshop | Jones, L.E. (2017) Making breastfeeding pain more manageable (presentation). Thai Breastfeeding Centre, Queen Sirikit National Institute of Child Health, Bangkok, Thailand. |
| 2017 | Conference Presentation | Jones, L.E. (2017) Development of a brief evidence-based educational intervention for improving clinical reasoning (presentation). World Confederation of Physical Therapy Asia-West Pacific Region Conference, Bangkok, Thailand. |
| 2017 | Conference Workshop (invited) | Jones, L.E. (2017). Pain and Movement Reasoning Model: Enhancing clinical reasoning when working with older person in pain (workshop). Australian Physiotherapy Association, National Conference, ICC, Sydney, Australia. |
| 2017 | Conference Presentation (invited) | Jones, L.E. (2017). Pain management in the older person: General principles for applying guidelines and protocols (presentation). Australian Physiotherapy Association, National Conference, ICC, Sydney, Australia. |

| Year | Presentation Type | Title |
|---|---|---|
| 2017 | Professional Workshop | Langford, J., Webb, J., Sherburn, M., Plante, A-F., & Jones L.E. (2017) Physiotherapy Masterclass (workshop), Pelvic Pain Victoria Weekend Workshop, Royal Melbourne Hospital, Melbourne, Australia. |
| 2017 | Conference Workshop | Holliday, S., Hayes, C., Gordon, J., Overton, S., & Jones, L.E. (2017) Time-efficient pain management in the office (TEMPO, presentation) Active Learning Module, GP17, ICC, Sydney, Australia. |
| 2018 | Professional Presentation | Jones, L.E. (2018) Pain and survivors: Chronic pain workshop, Victorian Foundation for Survivors of Torture, Melbourne, Australia. |
| 2018 | Conference Presentation | Jones, L.E. (2018) Applying the Pain and Movement Reasoning Model in physiotherapy practice: Protocol (poster). Pain Association of Singapore, Annual Scientific Meeting, Singapore. |
| 2019 | Conference Presentation | Jones, L.E., Heng, H., Heywood, S., Kent, S. & Amir, L.H. (2019) A brief evidence-based education intervention for improving clinical reasoning using the Pain and Movement Reasoning Model: Development, delivery and feedback (presentation). Asia Pacific Medical Education Conference (APMEC), Singapore. 9-13 January 2019 |
| 2019 | Conference Presentation (invited) | Jones, L.E. (2019) Preventing fear avoidance in low back pain (presentation). Association of South East Asian Pain Societies, Kuching, Sarawak, Malaysia. |
| 2019 | Conference Presentation (invited) | Jones, L.E. (2019) Pain assessment in survivors of torture: A case of vulnerability versus resilience (presentation). Association of South East Asian Pain Societies, Kuching, Sarawak, Malaysia. |
| 2019 | Professional Workshop | Jones, L.E. (2019) Stress, Pain and Recovery: Neuro-immuno-endocrine interactions and clinical practice (workshop) SITLEARN Singapore Institute of Technology, Singapore. 05 & 06 April 2019 |
| 2019 | Conference Presentation | Jones, L.E., Heng, H., Heywood, S., Kent, S. & Amir, L.H. (2019) Changing pain knowledge, attitudes and beliefs in the workplace: an on-site and on-line blended learning education intervention for physiotherapists (presentation). World Confederation of Physical Therapy Congress 2019, Geneva, Switzerland. |
| 2019 | Conference Presentation | Jones, L.E., Heng, H., Heywood, S., Kent, S. & Amir, L.H. (2019) A brief evidence-based education intervention for improving clinical reasoning using the Pain and Movement Reasoning Model: Development, delivery and feedback (presentation). World Confederation of Physical Therapy Congress 2019, Geneva, Switzerland. |
| 2019 | Professional Presentation (invited) | Jones, L.E. (2019) Understanding stress and pain – clinical implications (presentation). St. George's University of London, London, UK. 16 May 2019 |
| 2019 | Conference Presentation (invited) | Jones, L.E. (2019) Pain management in survivors of torture (presentation). Pain Clinic, Hospital Melaka, Pain Society Melaka & Malaysian Association for the Study of Pain, Melaka, Malaysia. |
| 2019 | Professional Presentation (invited) | Jones, L.E. (2019) Applying current concepts of pain to women's pain experiences (presentation). Obstetrics &Gynaecology Department [medical staff] National University Hospital, Singapore. 09 July 2019 |

| Year | Presentation Type | Title |
|---|---|---|
| 2019 | Professional Presentation (invited) | Jones, L.E. (2019) Applying current concepts of pain to women's pain experiences (presentation). Obstetrics &Gynaecology Department [maternity nurses and midwives], National University Hospital, Singapore. 25 July 2019 |
| 2019 | Professional Presentation (invited) | Jones LE (2019) Pain management in survivors of torture: a physiotherapist's perspective (presentation). Pain in Survivors of Torture Webinar, International Association for the Study of Pain Global Year Against Pain in the Most Vulnerable. Online 28 October 2019 |
| 2019 | Professional Presentation (invited) | Jones, L.E. (2019) Applying pain science to post-surgical pain using Pain and Movement Reasoning Model (presentation). Advanced Respiratory Care and Exercise Prescription in Onco-surgical Population Course Postgraduate Allied Health Institute, Singapore. 14 November 2019 |
| 2020 | Conference Presentation | Jones, L.E. (2020) Enhancing personal and clinical values through overseas placement experiences (presentation). Asia Pacific Medical Education Conference, Singapore. 10 January 2020 |
| 2020 | Professional Presentation (invited) | Jones, L.E. (2020) Pain and Movement Reasoning Model: Covering all the angles (presentation). Nepal Physiotherapy Association (NEPTA). Online 25 May 2020 |
| 2020 | Professional Presentation (invited) | Jones, L.E. (2020) "What is the one thing you really want people challenged by pain to know about?" Interview with Joshua Pate for International Association for the Study of Pain 'Relief' Platform. Recorded 31 July 2020 |
| 2020 | Professional Presentation (invited) | Jones, L.E. (2020) Pain and Movement Reasoning Model: Covering all the angles (presentation). Department of Musculoskeletal Sciences, Ashok & Rita Patel Institute of Physiotherapy, a constituent of Charotar University of Science and Technology (CHARUSAT), Gujarat, India. Online 10 August 2020 |

# Structure of thesis

This thesis is structured in accordance with La Trobe University's guidance for presentation of doctoral theses with published or submitted works. It contains two book chapters that have been published in edited books and an article published in a peer-reviewed journal. These published works have been presented in their published format. In addition, there are two articles that report on the doctoral project, which have been submitted to peer-reviewed journals.

**Chapter 1** provides an introduction to the thesis. It explores historical and contemporary challenges to the understanding and treatment of pain, including those specific to physiotherapy. Additionally, it presents accepted theories of pain and introduces elements of clinical reasoning. This chapter also provides an overview of the clinical reasoning tool, the Pain and Movement Reasoning Model.

**Chapter 2** explores the neuro-immune-endocrine interactions in relation to stress and pain. It provides additional theoretical support for the Pain and Movement Reasoning Model as well as presenting the implications of applying this knowledge in clinical practice. The contents of Chapter 2 are predominantly formed by the book chapter:

> **Jones, L. E.** (2017) Stress, pain and recovery: Neuro-immune-endocrine interactions and clinical practice. In: S. B. Porter, editor. Psychologically Informed Physiotherapy: Embedding Psychosocial Perspectives Within Clinical Management, pp. 78-106. Edinburgh, UK: Elsevier.

**Chapter 3** explores cognitive aspects of pain including the role of the meaning of pain. It draws on a body of work completed in collaboration with Dr Laura Whitburn and further enhances the theoretical tenets of the Pain and Movement Reasoning Model. The contents of Chapter 3 are predominantly formed by the book chapter:

> Whitburn, L. Y., & **Jones, L. E.** (2019). Labour pain. In S. van Rysewyk (Ed.), Meanings of Pain (Vol. 2), pp. 143-162. Springer. https://doi.org/10.1007/978-3-030-24154-4_8

**Chapter 4** describes the Methods for the doctoral research project in detail. It also includes an overview of education theory and strategies for conceptual change, reflecting the importance of these in developing an educational intervention.

**Chapter 5** reports on a mixed methods study evaluating an educational intervention, integrating the Pain and Movement Reasoning Model, in terms of the pain literacy of physiotherapists. This included using measures of pain knowledge, attitudes and beliefs about pain and person centredness, as well as focus groups and interviews. The contents of Chapter 5 are predominantly formed by the submitted paper:

> **Jones, L. E.**, Heng, H., Heywood, S., Kent, S., & Amir, L. H. (submitted). Improving pain literacy in the workplace using the Pain and Movement Reasoning Model: A mixed methods study of physiotherapists.

**Chapter 6** further explores the findings of the study presented in Chapter 5. Specifically, it reports on the qualitative findings with regard to the suitability of the Pain and Movement Reasoning Model for the different clinical areas that physiotherapists work. The study also explored the experiences of physiotherapists using the Model including perceived benefits to the clinical reasoning process. The contents of Chapter 6 are predominantly formed by the paper under review:

> **Jones, L. E.**, Heng, H., Heywood, S., Kent, S., & Amir, L. H. (under review). The suitability and utility of the Pain and Movement Reasoning Model for physiotherapy: A qualitative study.

**Chapter 7** explores the use of the Pain and Movement Reasoning Model by health professionals in contexts other than physiotherapy. The Model has been used to enhance clinicians' understanding of pain in breastfeeding women as shown in the published paper:

> Amir, L. H., **Jones, L. E.**, & Buck, M. L. (2015). Nipple pain associated with breastfeeding: Incorporating current neurophysiology into clinical reasoning. *Australian Family Physician, 44*(3), 127-132.

**Chapter 8** provides an overall discussion of the thesis. It begins with reflections on scholarly work that has been published recently, particularly on the application of the biopsychosocial model of health, and also considers how the physiotherapy profession continues to evolve. The chapter restates the important findings the doctoral research project and explains the impact of this thesis in terms of new knowledge and the potential for the broader application of the Pain and Movement Reasoning Model.

# Chapter 1 – Introduction

People with pain should have access to health professionals who can offer optimal advice, care and support. Pain is biopsychosocial in nature and, due to its complexity, can cause challenges to health care professionals working with people in pain. The traditions of physiotherapy practice are drawn from a biomedical paradigm which limits the clinician's clinical reasoning when working with a patient with pain. This Chapter presents the background to contemporary pain science, including theories of pain, and it introduces the Pain and Reasoning Model, a tool that can help physiotherapists integrate current concepts of pain into ways of thinking and practicing.

## 1.1 From the gate to the neuromatrix

A watershed moment in the understanding of the human pain experience was the publication of the Gate Control Theory in 1965 (Melzack & Wall, 1965). Patrick Wall, a neuroscientist, and Ronald Melzack, a psychologist, were working together at Massachusetts Institute of Technology, when they developed the Theory to explain their convictions that pain was an experience influenced by spinal and cortical mechanisms (Melzack, 1999).

Prior to this, the predominant thinking was that pain was the result of a hardwired system sending messages to the brain about tissue pathology (i.e. Specificity Theory) (Melzack & Wall, 1965). Research at the time, focused on the search for specific pain fibres and the pain centre in the brain. Specificity Theory predicts that when a particular type of nerve is stimulated, then a particular sensation will result (Wall, 1978). It follows, that the amount of pain is reflective of the amount of activity in the peripheral nerves; that is, the amount of injury or disease. This is clearly not the case, experimentally (Coghill, McHaffie, & Yen, 2003) and clinically (Melzack, Wall, & Ty, 1982).

By incorporating central modulation (i.e. spinal and brain modulatory mechanisms) into the explanation of pain, the variations in pain reports of patients with essentially similar pathological presentations, can be better understood. The incorporation of central modulation into clinical reasoning and decision-making, is a key feature of the project work presented in this thesis.

### 1.1.1 The spinal cord mechanism

In the Gate Control Theory, the metaphorical *gate* referred to the notion that when large diameter primary afferent fibres, specific to touch (A-beta fibres), were stimulated, they inhibited the second order neurons in the substantia gelatinosa of the dorsal horn of the spinal cord. This prevented the propagation of impulses from specialised small diameter primary afferents that transmit *nociception* (via A-delta and C fibres); also described by Wall as *injury* signals (Wall, 1978).

This mechanism was embraced enthusiastically in physiotherapy with the broad adoption of Transcutaneous Electrical Nerve Stimulation, a modality that could be applied to an area of skin that was neurologically convergent with the site of injury, or the source of *nociception* (Wall, 1978). The inhibition of second order neurons, due to the stimulation of large diameter sensory fibres, also supports a role for manual therapy in pain reduction (Pickar & Bolton, 2012).

For many clinicians and researchers, this mechanism of inhibition at the dorsal horn of the spinal cord was the extent of their understanding of the Gate Control Theory. It was certainly the best explained mechanism, perhaps because Wall and Melzack hoped to attract spinal cord researchers to this new way of thinking (Melzack, 1999). In a follow-up paper, Wall states, “The body of the paper mentioned other possible mechanisms but it has seemed to some that the entire theory rested on the diagrammatic mechanism . . . ” (Wall, 1978, p. 1).

Perhaps the more important idea from this theory was the inclusion of processing by the brain. The diagrammatic representation underplays this ‘central control’, representing it as an outlying feature to the main effect of the dorsal horn inhibition – although early diagrams by Melzack included the brain (Melzack, 1999; Wall, 1978). See Figure 1.1 for the diagrammatic representation of the evolution of the Gate Control Theory.

I would argue that by not acknowledging the modulating role of the brain, the conceptual understanding of the human pain experience remains relatively unchanged from the hard-wired view. This is most obvious in those who continued to talk of ‘pain fibres’ or ‘pain messages’, or even ‘pain pathways’ (Cook & Khan, 2007; Yin, Willard, Dixon, & Bogduk, 2008), when it is clear from the intentions of the Gate Control Theory that pain is not something that is transported from the site of pathology (Wall, 1978). A lot of clinical practice and pain research, including within the field of physiotherapy, has focused on reproducing ‘pain’ messages in clinical assessment or blocking or modifying them by therapeutic modalities applied to the periphery, usually without regard to the central effects that might be at play. This is obviously inadequate but aligns with the biomedical traditions of physiotherapy.

### 1.1.2 The Neuromatrix Theory

The Gate Control Theory established that the human pain experience requires a more sophisticated explanation than one that focuses solely on a peripheral trigger. However, it was far from comprehensive. Indeed, in Wall’s appraisal of the Gate Control Theory in 1996, he stated “I would only maintain that it was not a bad guess for its time.” (Wall, 1996, p. 16). Importantly, any conceptual model needs to explain all the variations of the human pain experience (Wall, 1978). This includes phantom pains, reported by those who have had traumatic or medically warranted amputation of a body part and, as

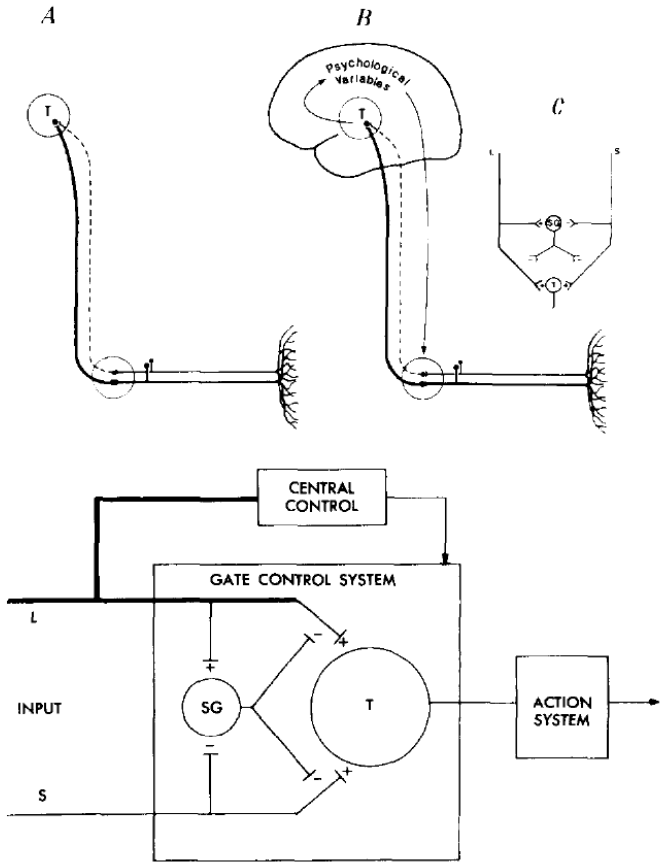


**Figure 1.1** The evolution of the gate control theory. *(A) show Noordenbos' model in which large, fast-conducting fibers inhibit small multisynaptic, slowly conducting fibers. Noordenbos (1959) says of the circle that represents the dorsal horns: 'In this circle which includes the substantia gelatinosa of Rolandi and its immediate adjacent parts, the multifiber pattern of afferent impulses is modified . . . The nature of this inhibitory interaction will not be further discussed . . . ' (B) An early development that led to the gate control theory in which the large fiber system is shown to activate psychological variables (such as meaning and past experience) that then project down to the dorsal horns and modulate the input. (C) Shows, a further development toward the gate control theory which comprises a theoretical presynaptic inhibition exerted by the substantia gelatinosa. The ideas gradually evolved into the model of the gate control theory shown at the bottom. (Figure and description originally published in Melzack, R. (1999). From the gate to the neuromatrix. Pain, 82, S121-S126. https://journals.lww.com/pain/pages/default.aspx The journal of the International Association for the Study of Pain).*

will be explored in Chapter 3, labour pain, an experience of pain during a natural physiological event.

Having considered both of these distinctive pain experiences (Katz & Melzack, 1990; Melzack, 1993a), Melzack developed the ideas from the Gate Control Theory further, and in the late 1990s published The Neuromatrix Theory (Melzack, 1999). This work describes a three stage process: first, inputs that influence and contribute to pain are grouped as cognitive-evaluative, sensory-discriminative and motivational-affective domains; second, the complex processing of these inputs involving a broad neural network or neuromatrix, importantly not a 'pain' matrix (Legrain, Iannetti, Plaghki, & Mouraux, 2011); finally, the outputs of this process including pain perception, action programs and stress regulation programs. The role of neuro-immune-endocrine inputs and outputs, including stress-related, has increasingly been the focus of research into pain mechanisms, and clinical practice, and will be explored further in Chapter 2.

Importantly the Neuromatrix Theory supports a continuous or cyclical processing of pain that can change from moment to moment (Melzack, 2005). It also promotes the idea that patterns of neural activity can be established that lead to the production of particular outcomes, described by Melzack as neurosignatures (Melzack, 2005), and what others have described as *neurotags* (Wallwork, Bellan, Catley, & Moseley, 2016). According to this theory, it is the pain neurosignature that produces the output of pain and it is clear from the example of phantom limb pain, that this can occur without input from the periphery. I consider the conception of pain as an output of central processing, not requiring nociceptive input, and the understanding that pain is dynamic in nature, to be threshold concepts for understanding pain (Barradell & Kennedy-Jones, 2015; Harden & Laidlaw, 2017). These important concepts of pain have informed the development of the Pain and Movement Reasoning Model, which I co-created, and is the focus of this thesis.

According to the Neuromatrix Theory, the goal of *pain treatment* should be the disruption of the pain neurosignature (Melzack, 1993b; Moseley, 2003; Moseley & Flor,

2012). Given the broad neural network Melzack describes, there are numerous treatment targets and any treatment modality that modifies the pattern of activity forming the pain neurosignature has the potential to be of benefit. This includes peripherally focused treatments that modify nociception, but also those that reduce the person's perceived threat or increases their sense of safety. Clinicians need to incorporate the complexity of pain processing into their clinical reasoning to take advantage of this scope of treatment options.

In introducing the Neuromatrix Theory in 1999, Melzack optimistically stated that the Gate Control Theory changed the way scientists and clinicians considered the relationship between psychological factors and pain (Melzack, 1999). That is, they had shifted from considering psychological factors as just being the result of a person's pain, to appreciating their contribution to the actual perception of pain. A few years later, reinforcing that further shift was still needed, Moseley, a physiotherapist and pain researcher (see Section 1.1.4), promoted the need for reconceptualisation of pain with an emphasis on an association with perceived threat (Moseley, 2007). Around the same time, I portrayed similar conceptual thinking, where pain modulation was influenced by the combination of *threat value*, of the context in which pain was experienced, and the *perceived vulnerability* the neuromatrix was processing (See Figure 1.2) (**Jones, L. E.**, 2007a). The importance of the meaning of pain and perceived safety will be explored further in Chapter 3.

### 1.1.3 We are not our brains

One concern that arose from incorporating brain modulation into the conceptual understanding of pain, was the increased focus on the brain as the cause of pain. The interpretation of this by some, particularly when pain persists, was that pain can be

attributed to pathological processing in the brain. In response to a philosophical discussion cautioning pain researchers and clinicians from attributing pain to the brain

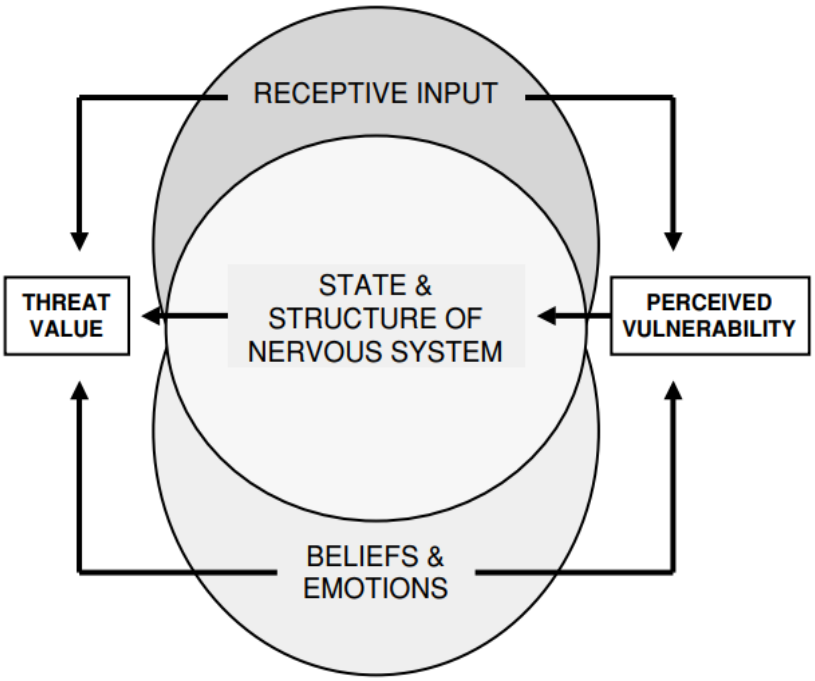


**Figure 1.2** Influences on pain perception. *Receptive input will be perceived as threatening due to pre-determined genetic influences on the nervous system or due to existing beliefs or emotions. As well as nociceptive input, visual input (e.g. blood, missing limb, bandage), auditory (e.g. audible cracks and clicks, being told you have a 'crumbling spine' or 'wear and tear'), proprioceptive (e.g. feelings of tightness; instability; weakness or incoordination; distorted 'virtual' body) and tactile (e.g. feeling deformity or altered temperature) input could also be interpreted as threatening. Where the individual identifies a particular ('virtual') body part to be vulnerable or under threat, the nervous system may become hypervigilant to all receptive input relating to the body part, for example its sensitivity will be heightened. It is therefore suggested that a specific combination of threatening receptive input and perceived vulnerability might trigger the individual pain neuromatrix with or without evidence of tissue damage. Threat value is the result of conscious and sub-conscious interpretation of input and perceived vulnerability refers to a concept of self (whole body or part of body). (Figure and description originally published in L.E. Jones (2007) An introduction to current concepts of pain. Figure 7.1.1 Influences on pain perception. In Partridge, C. (ed) Recent Advances in Physiotherapy, (p139), London, UK: John Wiley & Sons)*

(Thacker & Moseley, 2012), I co-wrote a letter to the editor, where we stated, " . . . health professionals must be careful not to fall back into retrograde tissue-model habits,

drawing focus on the reorganised homunculi of the brain as the next tissue target." (**Jones, L. E.** & Whitburn, 2012, p. 684). This aligns with research that has focused on pain as perception (Gallace & Bellan, 2018; Tabor, Thacker, Moseley, & Körding, 2017; Wiech, 2016) and the increased exploration of the embodiment of pain (Eccleston, 2018; Martínez et al., 2018; Nicholas & Ashton-James, 2017; Tabor, Keogh, & Eccleston, 2017), which offers a more 'first person' conceptualisation of pain (Thacker & Moseley, 2012).

### 1.1.4 Pain science leaders and the evolving profession

While over the last 10 years we are increasingly seeing evidence of a shift in physiotherapy research and practice, there are still those who try to deconstruct the biopsychosocial nature of pain (Ford et al., 2016), and for many years, those researching tendon pain did not consider there was a central element and focused on explanations involving microtrauma and local tissue degeneration (Alfredson & Cook, 2007; Cook & Khan, 2007; Cook & Purdam, 2009). Reviews by Littlewood and colleagues (2013) and Rio and colleagues (2014), were some of the first to systematically apply pain science to tendinopathy. This is important to note, as my part-time doctoral candidature began in 2014 and these, and subsequent reviews, are likely to have had an influence on physiotherapy practice. The aims and scope of the thesis, and the conclusions drawn, need to reflect the changing engagement of the profession with contemporary concepts of pain. Evidence from recent research suggests that newly graduated physiotherapists have a good awareness of the biopsychosocial nature of pain, but this does not always translate into practice (Barradell, Peseta, & Barrie, 2018; Forbes & Ingram, 2019; Stoikov et al., 2020; Tait, Clark, & Bellamy, 2018). Physiotherapists' ability to appropriately apply pain science in clinical practice will be explored in Chapter 5.

Although there are concerns about the translation to practice, there is evidence that physiotherapy has been one of the main health professions to embrace contemporary pain science (Hush, Nicholas, & Dean, 2018; Tait et al., 2018). It is worth highlighting some of the individuals who have facilitated this, especially those whose ideas, or collaboration, supported concepts presented in this thesis.

In the UK, Louis Gifford (1998) developed the Mature Organism Model. Like the concept of a *neuromatrix*, this *stress biology* Model of pain, drew on the concurrent and dynamic influence of broad mechanisms influencing the outputs of the brain, including pain (Gifford, 1998). The concept of the brain constantly *scrutinising* and reappraising a range of inputs, captures the dynamic nature of pain especially well. Gifford helped to establish the Physiotherapy Pain Association (Chartered Society of Physiotherapy, UK) and edited the *Topics in Pain* series. He supported physiotherapists, particularly in the UK, to become pain-informed across the late 1990s and early 2000s.

An early collaborator with Gifford, was David Butler who has perhaps had the most sustainable global impact with the Neuro Orthopedic Institute (NOI), which he established. In the mid 1990s Butler and colleagues organised the ‘Moving in on Pain’ conference with Patrick Wall, who was a strong advocate for the role of physiotherapy in pain, as the keynote presenter (Shacklock, 1995). Butler went on to publish the *Sensitive Nervous System* (Butler, 2000) and to develop the *Explain Pain* books (Butler & Moseley, 2013; Moseley & Butler, 2017) in collaboration with Lorimer Moseley, which draw on and extend elements of Neuromatrix Theory.

Lorimer Moseley has provided the lead for physiotherapists through the work with Butler, but also independently. He is based at the University of South Australia and leads a group that produces innovative research, including on the role of perception and pain. This focus can perhaps be drawn back to Melzack’s work identifying that pain is an

output of neural processing, that does not require the presence of tissue pathology, and on the perceptual construction of the ‘body self’ (Melzack, 2005; Wallwork et al., 2016).

The legacy left by Patrick Wall (1925-2001) and Ronald Melzack (1929-2019) has provided the foundation for much of contemporary pain science and influenced pain science leaders in physiotherapy. Despite this leadership, it has proven difficult for clinicians to apply contemporary concepts of pain into their practice – especially if they have not embraced the independence of central neural networks to produce pain. This thesis explores one way of supporting the translation of pain science concepts into clinical practice, the Pain and Movement Reasoning Model (see Section 1.3).

## 1.2 Reasoning processes and characteristics

Clinical reasoning is the thinking process that clinicians use to make sense of the signs and symptoms a person presents with, in order to guide evidence-based management (Jones, M. A., 2019). It can be seen as a collaborative process that relies on the characteristics of the clinician and the person seeking care (Elvén & Dean, 2017; Jones, M. A., 2019).

### 1.2.1 Types of thinking

When exploring clinical reasoning it is valuable to consider the types of thinking involved (Evans, 2019). Two distinct ways of making clinical decisions have been described, intuitive System 1 thinking and analytical System 2 thinking (Kahneman & Klein, 2009). These have evolved from dual process theory and are not defined neurological systems in the brain, but processes that are named to augment understanding (Kahneman, 2011). This understanding gives insight into how new information can be incorporated into the reasoning process.

The characteristics of System 1 operations are they are involuntary, low effort, and automatic (Kahneman & Klein, 2009). They lead to fast intuitive responses making the process difficult to analyse. While there are different schools of thought, the reported influences on System 1 thinking include experiences of a skilled performer (i.e. naturalistic decision-making) and the need for a simplified coherent solution and that will be affected by cognitive bias (i.e. heuristics and biases) (Kahneman & Klein, 2009).

There are parallels between the descriptions of System 1 thinking and a type of clinical reasoning competency (i.e. *correspondence competency*). Correspondence competency describes the accuracy of response to patient and contextual cues to establish a diagnosis (Custers, 2019). However, unlike the intuitive System 1 thinking, the *correspondence competent* clinician may be able to explain and analyse the identification of cues, perhaps drawn from established illness scripts, that led to the accurate diagnosis (Custers, 2019). This differentiates it from System 1 thinking, which is an intuitive process not readily open to explanation and analysis.

The characteristics of System 2 operations are they are voluntary, effortful and controlled (Kahneman & Klein, 2009). There are different ways of considering the relationship between System 1 and System 2 processes. One idea is that System 2 thinking allows refinement and consolidation of the initial automatic idea (i.e. naturalistic decision-making). An alternate view is that System 2 operations monitor the quality of the automatic thought and are activated when there is complexity, or when an unexpected cue is detected (Kahneman & Klein, 2009).

System 2 thinking strives for coherence of the analysis of the information and has parallels to another type of clinical reasoning competency, *coherence competency* (Custers, 2019). Coherence competency is reflected in the ability of a clinician to come up with a diagnostic hypothesis that has minimal inconsistencies and that can be defended with logical argument (Custers, 2019).

It is important to recognise that coherence is easier when there is less information to make sense of (Custers, 2019; Jones, M. A., 2019). Arguably then, coherence can be achieved more easily using the simpler biomedical framework, than a biopsychosocial framework. This becomes troublesome if the clinician undervalues the importance of the psychosocial factors, or due to lack of knowledge or established biases does not attend to cues or information that might disrupt the coherence. The biases may involve a conscious decision by the clinician that information is not important to include or, through confirmation bias, the clinician only see the cues and information that fit with the established framework or way of thinking (Jones, M. A., 2019). It is apparent that this could impact on System 1 and System 2 operations.

### 1.2.2 Pathoanatomical traditions

Physiotherapy practice has traditionally followed a biomedical approach to assessment and decision-making. This way of thinking attributes pain to pathoanatomic factors and ideas of pain more aligned with Specificity Theory. As well, a biomedical approach has been associated with a clinician-centred approach, rather than a patient-centred approach and leads to a focus on body structures and function (Elvén & Dean, 2017). There is evidence that both physiotherapist and patient beliefs are important in the treatments that are employed (Gardner et al., 2017; Traeger, Moynihan, & Maher, 2017), so when these beliefs relate predominantly to a pathoanatomical explanation of pain, there is a risk of delivering low value care (Croft, Sharma, & Foster, 2020; Traeger et al., 2017).

### 1.2.3 A call to change

The physiotherapy profession advocates for a shift from biomedical traditions and the adoption of a biopsychosocial philosophy of practice (Barradell, 2019; Elvén & Dean, 2017; Jones, M. A., 2019). This is supported by guidance for pre-registration education,

published by the World Confederation of Physical Therapy (2011), which identifies that clinical practice includes physical, psychological, emotional and social and well-being domains. In alignment with this, in 2011, the American Physical Therapy Association published a special issue of its official journal, *Physical Therapy*, focusing on psychologically informed physiotherapy, including treatment decision strategies for low back pain (Nicholas & George, 2011), and an edited book titled *Psychologically Informed Physiotherapy* was published in 2017 (a chapter from this book is presented as part of this thesis – see Chapter 2). In the latest edition of Jones and Rivett's authoritative clinical reasoning text for musculoskeletal clinicians (Jones, M. A. & Rivett, 2019), there are newly added chapters to support these concepts, including one dedicated to pain science (Catley, Moseley, & Jones, 2019) and another on psychosocial influences including stress (Hammerich, Scherer, & Jones, 2019); although the latter does not cite any sources from the last 10 years.

To help clinicians frame their clinical reasoning, Jones and Rivett (2019) promote ten 'hypothesis' categories including one on pain type. In a recent qualitative systematic review, Elvén and colleagues (2017) organised the influences on clinical reasoning into four themes: (i) the clinician as a source, including attitudes and beliefs about clinical practice, knowledge and critical reflection; (ii) the person seeking care as a source, including the biopsychosocial nature of their condition; (iii) the aspects of the reasoning process itself, including the orientation of the interaction (i.e. person-centred or clinician-centred); and (iv) context, relating to the external circumstances. The unpacking of the reasoning process in these ways promotes a person-centred approach and the inclusion of contextual elements supports the importance of psychological and social factors. Adopting such a biopsychosocial way of thinking, broadens the nature and content of what clinicians should consider in a clinical reasoning process.

### 1.2.4 What is missing?

Despite this call to change and some apparent shift by the profession, Barradell (2019) reported “physiotherapists remain tied to therapist-led perspectives” (p. 3). Moseley and Butler (2015), in their reflection on 15 years of *Explain Pain*, were still promoting the need to shift to a biopsychosocial paradigm, concluding “we should continue to strive toward understanding this experience of pain, in all its complexity” (p. 811).

However, understanding pain is not enough. Physiotherapists need to be able to appropriately translate concepts, relating to the complexity of pain, into their clinical decisions and management. Challenges to adopting a biopsychosocial approach to pain include low confidence to implement new ways of working and concerns that psychosocial assessment is outside physiotherapy’s scope of practice (Gardner et al., 2017). In their systematic review into the influence of physiotherapists’ beliefs and attitudes on clinical practice, Gardner and colleagues concede that while attitudes and beliefs have been shown to align with clinical practice, the interaction between the patient and clinician are also influential. In particular, the therapists’ confidence in delivering a biopsychosocial approach and the passivity of the patient were found to be important.

Therapist confidence in applying pain concepts may be affected by their clinical area. Some clinical groups within physiotherapy have sought to embrace contemporary pain concepts, for example many musculoskeletal and women’s health physiotherapists. These clinical groups foster new ways of thinking and practicing through professional development opportunities but these opportunities are not always available or promoted to all. As a result, it is likely there are physiotherapists working with patients with pain

who have yet to consider different ways of thinking about pain, or who may be inconsistent, or lack confidence, in applying a biopsychosocial approach to pain.

Physiotherapists limited application of a biopsychosocial approach topain is concerning, as they will often be working with patients in pain. Anyone exposed to a threat to their bodies or with a movement disorder could be expected to report pain. This would include people having surgery (Gan, 2017), a high percentage of stroke survivors (Henon, 2006) and people with burns (Gauffin, Öster, Sjöberg, Gerdin, & Ekselius, 2016). All physiotherapists should have access to quality training in contemporary pain concepts and supported to integrate these into ways of thinking and practicing in their clinical context.

## 1.3 The Pain and Movement Reasoning Model

The Pain and Movement Reasoning Model is not a theoretical Model but a diagrammatical model, representing a way of thinking through the contributors to pain. It was designed as a tool to assist clinical reasoning and also to assist teaching the multidimensionality of pain (**Jones, L. E.** & O'Shaughnessy, 2014). It draws on the strong association, and shared influences, of pain and movement (Cott et al., 1995; Hodges & Smeets, 2015; Hodges & Tucker, 2011; Merkle, Sluka, & Frey-Law, 2018; Meulders, Vansteenwegen, & Vlaeyen, 2011; Zusman, 2008), along with theoretical concepts from Melzack's Neuromatrix Theory (1999, 2005) and Gifford's Mature Organism Model (1998). It is informed by the approach to person-centredness described in the World Health Organization International Classification of Function, Disability and Health (ICF) (World Health Organization, 2018) and embeds an integrated biopsychosocial approach into formulation and decision-making (**Jones, L. E.** & O'Shaughnessy, 2014).

### 1.3.1 Development of the Model: a personal account

Des O'Shaughnessy, who I had known for several years, invited me to develop a clinical reasoning and education tool, around 2003. He was working as the physiotherapy lead in an inner London, Community Health Centre and he was finding it challenging to support his junior staff in their professional development around pain. He had developed a collection of annotated triangles, referred to by his staff as Des' pyramids (see Figure 1.3). Over a 6 month period, Des and I shared our ideas and drafts

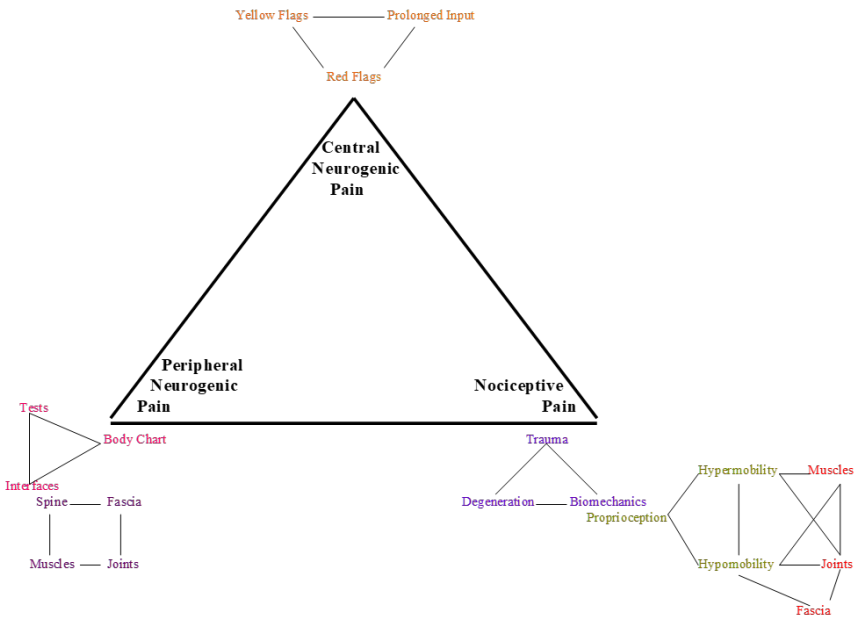


**Figure 1.3** Des' pyramids.
*Published with permission of author (Des O'Shaughnessy)*

(see Figure 1.4) as we refined a model that conceptually captured the complexity of pain, while being a relatively simple tool to explain and use (**Jones, L. E.** & O'Shaughnessy, 2014). The Model was then adopted in our respective workplaces and we developed a manuscript for publication (**Jones, L. E.** & O'Shaughnessy, 2014). Only one significant change was required from the first iteration of the Model: the term 'central

sensitisation', which at the time was increasingly being used incorrectly as a direct reference to 'chronic pain', was replaced with central modulation.

### 1.3.2 Categories of the Model

The Model consists of three categories representing pain mechanisms. As authors of the Model we labelled these and proposed some definitions but are open to these labels being changed, as long as the Model preserves a multidimensional framework.

*Local stimulation* relates to mechanisms such as inflammation and distortion of tissues that are likely to stimulate local nociceptors (chemical and mechanical); that is local to the site of pain. *Regional influences* relates to mechanisms that are remote to the site of pain, such as occurs with referred pain, or when dysfunction in a structure creates stress and symptoms at a distant site; as in the notion of biomechanics and the kinetic chain. We also include aspects of peripheral nerve sensitivity in this category such as is seen in neurogenic inflammation. The third category is *Central modulation* and refers to the broad range of moderators and mediators that can influence pain perception via central processing. This incorporates predisposing issues including history of adverse life events, previous pain experiences and health conditions, particular inflammatory conditions. It also recognises classic central sensitization processes where an afferent barrage from peripheral nerves can lead to more efficient pain production. Finally, we included cognitive, emotional and social contexts, that may or may not be pain-related, but can contribute to the pain experience (see **Jones** & O'Shaughnessy (2014) for comprehensive introduction to the Model).

When clinical reasoning, the clinician identifies signs, symptoms and history during clinical assessment that are related to each category. Then, on the gridded triangle, the clinician plots one mark representing the relative contributions of each

category. This process of formulation allows a clinical judgement about which category of mechanisms is predominant, and therefore the focus of treatment.

Three examples of application of the Model are presented in Appendix D. The first example describes using the Model in initial assessment and the second is an example of using it to explore a patient's unexpected flareup of symptoms. The third example reports on the use of the Model as a tool to assist patient education about pain. In particular, how the categories of the Model can support a conversation about the multiple factors that might be impacting on the person's pain.

### 1.3.3 Application of the Model

Before now, there has not been a formal evaluation of how the Model has been applied or of its suitability or utility. Both Des O'Shaughnessy and I have found it valuable in our clinical work and I have also found it useful in professional education.

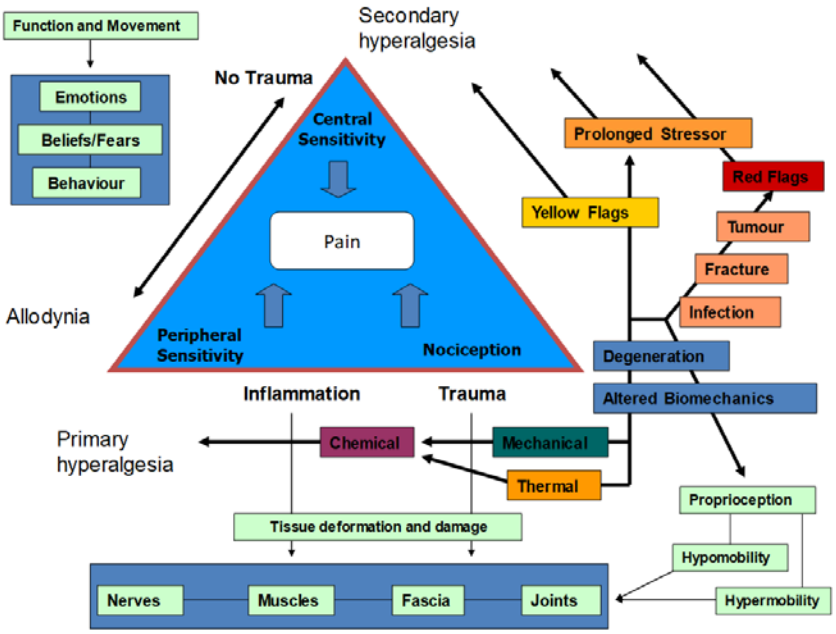


**Figure 1.4** Early draft of Pain and Movement Reasoning Model. *(Lester Jones)*

The most consistent use in an education context has been in my postgraduate teaching on musculoskeletal and sports physiotherapy programs. Online discussion boards were used in the delivery of pain topics, and some of the students' posts were impressive, including descriptions of how their use of the Model supported a paradigm shift to a biopsychosocial way of thinking and practicing. They identified that the Model allowed for the dynamic nature of pain and also forced the integration of information. It also led to a more person-centred approach with greater emphasis on the individual and social determinants of pain. Interestingly and appropriately, some stated that they modified aspects of the Model to apply it in their particular clinical context. These shared comments provide the impetus for pursuing a more formal evaluation of the Pain and Movement Reasoning Model, both as a tool assisting clinical reasoning and as a framework for pain education.

## 1.4 Aims and scope of thesis

### 1.4.1 Aims

To identify the impact of educating physiotherapists about the Pain and Movement Reasoning Model in terms of knowledge, attitudes and beliefs about pain and person-centred care.

To evaluate the utility of the Pain and Movement Reasoning Model and determine its suitability in different clinical areas as perceived by physiotherapists working in those areas.

### 1.4.2 Objectives

To measure the effect of an education package, incorporating the Pain and Movement Reasoning Model, on improvement of pain knowledge, attitudes and beliefs in physiotherapists working with people with painful conditions.

To identify changes in perceived person-centred care, in response to an education package incorporating the Pain and Movement Reasoning Model, from the perspective of physiotherapists and their patients.

To examine physiotherapists' perceptions of the utility and suitability of the Pain and Movement Model across a range of clinical contexts.

### 1.4.3 Primary hypotheses

Training in the use of the Pain and Movement Reasoning Model improves knowledge about neurophysiology of pain in physiotherapists.

Training in the use of the Pain and Movement Reasoning Model alters attitudes and beliefs about pain in those with predominantly biomedical attitudes and beliefs about pain.

Physiotherapists, from a range of clinical contexts, will find the Pain and Movement Reasoning Model useful in their clinical practice and suitable in a range of clinical settings.

### 1.4.4 Secondary hypothesis

Training in the use of the Pain and Movement Reasoning Model improves the person centeredness of clinical interactions in those who initially hold predominantly biomedical attitudes and beliefs about pain.

## 1.5 Researcher context

It is appropriate to report on my education and professional experience as it influences how I have prepared this thesis, but also for reference when considering my analyses of the research findings, especially the qualitative analyses.

I have had a privileged education, both in terms of what I have been exposed to, and the timing of my engagement with the study of pain. In my first degree I majored in

psychology and physiology and completed a project on *Stress and the Menstrual Cycle*. I have no doubt the awareness of the influences of psychosocial factors on health and well-being, shaped my professional identity as I progressed through physiotherapy training. My final clinical placement in my physiotherapy training, was in Malawi, in East Africa. My experiences there, reinforced the importance of culture on health and made me question the universal appropriateness of physiotherapy. After graduation, I enhanced my counselling skills by completing postgraduate studies in 'Behaviour Studies in Healthcare' and then completed my Masters in 'Pain Management' in 1999. The timing of this was perfect as I was able to establish a solid foundation of concepts and theory on which to organise, and make sense of, the rapid increase in knowledge based on pain research since I graduated. My Masters research project examined the pain knowledge of final year Australian physiotherapy students (unpublished). My last formal education was to complete a postgraduate certificate in learning and teaching which required the completion of a critically reflective portfolio.

I am an Australian Physiotherapy Association member and titled Pain Physiotherapist and I was the inaugural Chair of the National Pain Group in Australia. My clinical work has primarily been in musculoskeletal settings and dedicated pain clinics, including the internationally renowned University of Sydney, Pain Management and Research Institute, where I worked alongside Professors Michael Cousins and Michael Nicholas. My pro bono work has included providing physiotherapy to people who have experienced torture and I am currently on the committee of the International Association for the Study of Pain Special Interest Goup, *Pain associated with Torture, Organised Violence and War*, chaired by the prolific pain researcher and thinker, Dr Amanda Williams.

Since 2000, my main work has been in academic institutions in UK, Australia and Singapore. This included leading the pain sciences topics, initially developed and

facilitated by David Butler and NOI, for La Trobe University's Masters programmes in Musculoskeletal and Sports Physiotherapy. I have also been invited by other organisations to contribute to developing online resources including the Faculty of Pain Medicine 'Better Pain Management' series, and lectures on persistent pain for trainee Psychiatrists at University of Melbourne.

I have contributed to a number of scholarly works on pain including chapters in *Recent Advances in Physiotherapy* (**Jones, L. E.**, 2007a, 2007b; **Jones, L. E.** & Wang, 2007), co-authoring a chapter with Professor Lorimer Moseley for *Tidy's Physiotherapy* (Moseley & Jones, 2008; Moseley, Jones, & Carus, 2013), and an editorial for *Journal of Physiotherapy* with Professor Julia Hush (**Jones, L. E.** & Hush, 2011).

I completed a six-month research residency with the Judith Lumley Centre, a research centre at La Trobe University focused on evidence-based care of mother and child (see Section 3.1.1). During this time I shared my knowledge of contemporary pain science with researchers investigating women's birth experiences and outcomes. Outputs from the residency included a qualitative project on women's expectations and experience of labour pain (Whitburn, Jones, Davey, & Small, 2014). I then supported Dr. Laura Whitburn further develop those ideas during her PhD candidature. Chapter 3 represents our continuing work related to understanding the meaning of pain.

As an educator I have strived to be evidence-based and an early adopter of technology. Published work includes the development of online resources (**Jones, L. E.**, 2011), the use of technologies (**Jones, L. E.**, Mackenzie, & Wong, 2010) and the design of learning activities (**Jones, L. E.**, 2016). The importance of having someone with formal training and experience designing and delivering the education interventions in research will be discussed in Chapter 4.

The sharing of my professional experience provides the reader with some additional context on which to engage with this thesis. It also offers some insight into the choice of the included publications and how they fit into an overall body of work.

## 1.6 References


Alfredson, H., & Cook, J. (2007). A treatment algorithm for managing Achilles tendinopathy: new treatment options. *British Journal of Sports Medicine, 41*(4), 211-216.

Barradell, S. (2019). Caring in and for physiotherapy through stewardship. *Physiotherapy Theory and Practice*, https://doi.org/10.1080/09593985.2019.1641868

Barradell, S., & Kennedy-Jones, M. (2015). Threshold concepts, student learning and curriculum: Making connections between theory and practice. *Innovations in Education and Teaching International, 52*(5), 536-545.

Barradell, S., Peseta, T., & Barrie, S. (2018). 'There's so much to it': The ways physiotherapy students and recent graduates experience practice. *Advances in Health Sciences Education, 23*(2), 387-406.

Butler, D. S. (2000). *The Sensitive Nervous System*, Adelaide, Australia: Noigroup publications.

Butler, D. S., & Moseley, G. L. (2013). *Explain Pain* (2nd ed.), Adelaide, Australia: Noigroup publications.

Catley, M. J., Moseley, G. L., & Jones, M. A. (2019). Understanding pain in order to treat patients in pain. In M. A. Jones & D. A. Rivett (Eds.), *Clinical Reasoning in Musculoskeletal Practice* (2nd ed.), pp. 32-46. Sydney, Australia: Elsevier.

Coghill, R. C., McHaffie, J. G., & Yen, Y.-F. (2003). Neural correlates of interindividual differences in the subjective experience of pain. *Proceedings of the National Academy of Sciences, 100*(14), 8538-8542.

Cook, J. L., & Khan, K. M. (2007). Etiology of tendinopathy. In S. L.-Y. Woo, P. A. F. H. Renstrom , & S. P. Arnoczky (Eds.), *Tendinopathy in Athletes*, pp. 10-28. Oxford, UK: Blackwell.

Cook, J. L., & Purdam, C. R. (2009). Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy. *British Journal of Sports Medicine, 43*(6), 409-416.

Cott, C. A., Finch, E., Gasner, D., Yoshida, K., Thomas, S. G., & Verrier, M. C. (1995). The Movement Continuum Theory of physical therapy. *Physiotherapy Canada, 47*(2), 87-95.

Croft, P., Sharma, S., & Foster, N. E. (2020). Primary care for low back pain: We don't know the half of it. *Pain, 161*(4), 663-665.

Custers, E. J. F. M. (2019). Theories of truth and teaching clinical reasoning and problem solving. *Advances in Health Sciences Education, 24*, 839–848.

Eccleston, C. (2018). Chronic pain as embodied defence: Implications for current and future psychological treatments. *Pain, 159*, S17-S23.

Elvén, M., & Dean, E. (2017). Factors influencing physical therapists' clinical reasoning: Qualitative systematic review and meta-synthesis. *Physical Therapy Reviews, 22*(1-2), 60-75.

Evans, J. S. B. (2019). Reflections on reflection: The nature and function of type 2 processes in dual-process theories of reasoning. *Thinking & Reasoning, 25*(4), 383-415.

Forbes, R., & Ingram, M. (2019). New-graduate physiotherapists' readiness for practice and experiences of managing chronic pain; a qualitative study. *Physiotherapy Theory and Practice*, https://doi.org/10.1080/09593985.2019.1692394

Ford, J., Hahne, A. J., Surkitt, L. D., Chan, A. Y., Richards, M. C., Slater, S. L., . . . Taylor, N. F. (2016). Individualised physiotherapy as an adjunct to guideline-based advice for low back disorders in primary care: A randomised controlled trial. *British Journal of Sports Medicine, 50*(4), 237-245.

Gallace, A., & Bellan, V. (2018). The parietal cortex and pain perception: A body protection system. *Handbook of Clinical Neurology, 151*, 103-117.

Gan, T. J. (2017). Poorly controlled postoperative pain: Prevalence, consequences, and prevention. *Journal of Pain Research, 10*, 2287-2298.

Gardner, T., Refshauge, K., Smith, L., McAuley, J., Hübscher, M., & Goodall, S. (2017). Physiotherapists' beliefs and attitudes influence clinical practice in chronic low back pain: a systematic review of quantitative and qualitative studies. *Journal of Physiotherapy*, *63*(3), 132-143.

Gauffin, E., Öster, C., Sjöberg, F., Gerdin, B., & Ekselius, L. (2016). Health-related quality of life (EQ-5D) early after injury predicts long-term pain after burn. *Burns, 42*(8), 1781-1788.

Gifford, L. (1998). Pain, the tissues and the nervous system: A conceptual model. *Physiotherapy, 84*(1), 27-36.

Hammerich, A. S., Scherer, S. A., & Jones, M. A. (2019). Influence of stress, coping and social factors on pain and disability in musculoskeletal practice. In M. A. Jones & D. A. Rivett (Eds.), *Clinical Reasoning in Musculoskeletal Practice* (2nd ed.), pp. 47-70. Sydney, Australia: Elsevier.

Harden, R. M., & Laidlaw, J. M. (2017). Responding to information overload and building options into a core curriculum with threshold concepts *Essential Skills for a Medical Teacher: An Introduction to Teaching and Learning in Medicine* (2nd ed.), pp. 145-158. London, UK: Elsevier.

Henon, H. (2006). Pain after stroke: A neglected issue. *Journal of Neurology, Neurosurgery and Psychiatry, 77*(5), 569-569.

Hodges, P. W., & Smeets, R. J. (2015). Interaction between pain, movement, and physical activity: Short-term benefits, long-term consequences, and targets for treatment. *The Clinical Journal of Pain, 31*(2), 97-107.

Hodges, P. W., & Tucker, K. (2011). Moving differently in pain: A new theory to explain the adaptation to pain. *Pain, 152*(3), Supplement 1, S90-S98. https://doi.org/10.1016/j.pain.2010.10.020

Hush, J. M., Nicholas, M., & Dean, C. M. (2018). Embedding the IASP pain curriculum into a 3-year pre-licensure physical therapy program: Redesigning pain education for future clinicians. *Pain Reports, 3*(2): e645. https://doi.org/10.1097/PR9.0000000000000645

**Jones, L. E.** (2007a). An introduction to current concepts of pain. In C. Partridge (Ed.), *Recent Advances in Physiotherapy*, pp. 135-141. London, UK: John Wiley & Sons.

**Jones, L. E.** (2007b). Non-specific arm pain. In C. Partridge (Ed.), *Recent Advances in Physiotherapy*, pp. 142-158. London, UK: John Wiley & Sons.

**Jones, L. E.** (2011). Introducing the ICF: The development of an online resource to support learning, teaching and curriculum design. *Physiotherapy, 97*(1), 55-58.

**Jones, L. E.** (2016). Beyond information giving: Use of a blended approach to reflection to promote skill development in physiotherapy. In A. Peterkin & P. Brett-Maclean (Eds.), *Keeping Reflection Fresh*, pp. 363-367. Kent, Ohio: Kent State University Press.

**Jones, L. E.**, & Hush, J. M. (2011). Pain education for physiotherapists: Is it time for curriculum reform? *Journal of Physiotherapy, 57*(4), 207-208.

**Jones, L. E.**, Mackenzie, M., & Wong, M.-S. (2010). The use of videoconference technology: Creating innovative and interactive fieldwork education experiences. In L. McAllister, M. Paterson, J. Higgs and C. Bithell (Eds.), *Innovations in Allied Health Fieldwork Education: A Critical Appraisal*, pp. 167-175. Rotterdam, The Netherlands: Brill Sense.

**Jones, L. E.**, & O'Shaughnessy, D. F. P. (2014). The Pain and Movement Reasoning Model: Introduction to a simple tool for integrated pain assessment. *Manual Therapy, 19*(3), 270-276.

**Jones, L. E.**, & Wang, A. P. (2007). Recurrent lumbar pain after failed spinal surgery. In C. Partridge (Ed.), *Recent Advances in Physiotherapy*, pp. 159-180. London, UK: John Wiley & Sons.

**Jones, L. E.**, & Whitburn, L. Y. (2012). First-person neuroscience and the understanding of pain. *The Medical Journal of Australia, 196*(11), 684.

Jones, M. A. (2019). Clinical reasoning: fast and slow thinking in musculoskeletal practice. In M. A. Jones & D. A. Rivett (Eds.), *Clinical Reasoning in Musculoskeletal Practice* (2nd ed.), pp. 2 -31. Sydney, Australia: Elsevier.

Jones, M. A., & Rivett, D. A. (2019). *Clinical Reasoning in Musculoskeletal Practice* (2nd ed.), Sydney, Australia: Elsevier.

Kahneman, D. (2011). Thinking, Fast and Slow. *Talks at Google.* Retrieved from https://youtu.be/CjVQJdIrDJ0

Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise: A failure to disagree. *American Psychologist, 64*(6), 515-526.

Katz, J., & Melzack, R. (1990). Pain 'memories' in phantom limbs: Review and clinical observations. *Pain, 43*(3), 319-336. https://doi.org/10.1016/0304-3959(90)90029-D

Legrain, V., Iannetti, G. D., Plaghki, L., & Mouraux, A. (2011). The pain matrix reloaded: A salience detection system for the body. *Progress in Neurobiology, 93*(1), 111-124.

Littlewood, C., Malliaras, P., Bateman, M., Stace, R., May, S., & Walters, S. (2013). The central nervous system – An additional consideration in 'rotator cuff tendinopathy'and a potential basis for understanding response to loaded therapeutic exercise. *Manual Therapy, 18*(6), 468-472.

Martínez, E., Aira, Z., Buesa, I., Aizpurua, I., Rada, D., & Azkue, J. J. (2018). Embodied pain in fibromyalgia: Disturbed somatorepresentations and increased plasticity of the body schema. *PloS One, 13*(4), e0194534. https://doi.org/10.1371/journal.pone.0194534

Melzack, R. (1993a). Labour pain as a model of acute pain. *Pain, 53*(2), 117-120.

Melzack, R. (1993b). Pain: Past, present and future. *Canadian Journal of Experimental Psychology, 47*(4), 615.

Melzack, R. (1999). From the gate to the neuromatrix. *Pain, 82*, S121-S126.

Melzack, R. (2005). Evolution of the neuromatrix theory of pain. The Prithvi Raj Lecture: presented at the third World Congress of World Institute of Pain, Barcelona 2004. *Pain Practice, 5*(2), 85-94.

Melzack, R., & Wall, P. D. (1965). Pain mechanisms: A new theory. *Science, 150*(3699), 971-979.

Melzack, R., Wall, P. D., & Ty, T. C. (1982). Acute pain in an emergency clinic: Latency of onset and descriptor patterns related to different injuries. *Pain, 14*(1), 33-43.

Merkle, S. L., Sluka, K. A., & Frey-Law, L. A. (2018). The interaction between pain and movement. *Journal of Hand Therapy*, *33*(1), 60-66.

Meulders, A., Vansteenwegen, D., & Vlaeyen, J. W. (2011). The acquisition of fear of movement-related pain and associative learning: A novel pain-relevant human fear conditioning paradigm. *Pain, 152*(11), 2460-2469.

Moseley, G. L. (2003). A pain neuromatrix approach to patients with chronic pain. *Manual Therapy, 8*(3), 130-140.

Moseley, G. L. (2007). Reconceptualising pain according to modern pain science. *Physical Therapy Reviews, 12*(3), 169-178.

Moseley, G. L., & Butler, D. S. (2015). Fifteen years of explaining pain: The past, present, and future. *The Journal of Pain, 16*(9), 807-813.

Moseley, G. L., & Butler, D. S. (2017). *Explain Pain Supercharged*, Adelaide, Australia: noigroup.

Moseley, G. L., & Flor, H. (2012). Targeting cortical representations in the treatment of chronic pain: A review. *Neurorehabilitation and Neural Repair, 26*(6), 646-652.

Moseley, G. L., & **Jones, L. E.** (2008). Pain. In S. B. Porter (Ed.), *Tidy's Physiotherapy* (14th ed.). London, UK: Churchill Livingstone.

Moseley, G. L., **Jones, L. E.**, & Carus, C. (2013). Pain. In S. Porter (Ed.), *Tidy's Physiotherapy* (15th ed.). London, UK: Churchill Livingstone.

Nicholas, M. K., & Ashton-James, C. (2017). Embodied pain: Grasping a thorny problem? *Pain, 158*(6), 993-994.

Nicholas, M. K., & George, S. Z. (2011). Psychologically informed interventions for low back pain: An update for physical therapists. *Physical Therapy, 91*(5), 765-776.

Pickar, J. G., & Bolton, P. S. (2012). Spinal manipulative therapy and somatosensory activation. *Journal of Electromyography and Kinesiology, 22*(5), 785-794.

Rio, E., Moseley, G. L., Purdam, C., Samiric, T., Kidgell, D., Pearce, A. J., . . . Cook, J. L. (2014). The pain of tendinopathy: Physiological or pathophysiological? *Sports Medicine, 44*(1), 9-23.

Shacklock, M. (1995). *Moving in on Pain*, Oxford, UK: Butterworth-Heinemann.

Stoikov, S., Maxwell, L., Butler, J., Shardlow, K., Gooding, M., & Kuys, S. (2020). The transition from physiotherapy student to new graduate: Are they prepared? *Physiotherapy Theory and Practice*, 1-11. doi:10.1080/09593985.2020.1744206

Tabor, A., Keogh, E., & Eccleston, C. (2017). Embodied pain—negotiating the boundaries of possible action. *Pain, 158*(6), 1007-1011.

Tabor, A., Thacker, M. A., Moseley, G. L., & Körding, K. P. (2017). Pain: A statistical account. *PLoS Computational Biology, 13*(1), e1005142.

Tait, D., Clark, C. J., & Bellamy, R. (2018). Attitudes and beliefs relating to pain management among undergraduate students in six health care programmes. *British Journal of Pain*, *12*(2), S20-21.

Thacker, M. A., & Moseley, G. L. (2012). First-person neuroscience and the understanding of pain. *Medical Journal of Australia, 196*(6), 410-411.

Traeger, A. C., Moynihan, R. N., & Maher, C. G. (2017). Wise choices: Making physiotherapy care more valuable. *Journal of Physiotherapy, 63*(2), 63-65.

Wall, P. D. (1978). The gate control theory of pain mechanisms: A re-examination and re-statement. *Brain, 101*(1), 1-18.

Wall, P. D. (1996). Comments after 30 years of the gate control theory. *Pain Forum*, *5*(1), 12-22.

Wallwork, S. B., Bellan, V., Catley, M. J., & Moseley, G. L. (2016). Neural representations and the cortical body matrix: Implications for sports medicine and future directions. *British Journal Sports Medicine*, *50*, 990-996.

Whitburn, L. Y., **Jones, L. E.**, Davey, M.-A., & Small, R. (2014). Women′s experiences of labour pain and the role of the mind: An exploratory study. *Midwifery, 30*(9), 1029-1035.

Wiech, K. (2016). Deconstructing the sensation of pain: The influence of cognitive processes on pain perception. *Science, 354*(6312), 584-587.

World Confederation of Physical Therapy. (2011). WCPT Guideline for Physical Therapist Professional Entry Level Education. Retrieved from https://www.wcpt.org/guidelines/entry-level-education.

World Health Organization. (2018). International Classification of Functioning, Disability and Health (ICF). Retrieved from https://www.who.int/classifications/icf/en/

Yin, W., Willard, F., Dixon, T., & Bogduk, N. (2008). Ventral innervation of the lateral C1–C2 joint: An anatomical study. *Pain Medicine, 9*(8), 1022-1029.

Zusman, M. (2008). Associative memory for movement-evoked chronic back pain and its extinction with musculoskeletal physiotherapy. *Physical Therapy Reviews, 13*(1), 57-68.

# Chapter 2 – Stress, pain and recovery

Chapters 2 and 3 focus on two areas receiving increased consideration in physiotherapy forums: the effect of the stress regulation system on pain and the cognitive-evaluative dimension of pain perception. In this chapter I present a detailed exploration of the interactions between the nervous, immune and endocrine systems in the stress response and the association with pain and healing (Jones, 2017).

## 2.1 Introduction to published work

The book chapter, *Stress, Pain and Recovery* (Jones, 2017), was published in a first edition physiotherapy textbook that aimed to present a psychologically informed approach to clinical management. It is part of Elsevier's Physiotherapy Essentials series. The editor, who I had worked with previously on two editions of *Tidy's Physiotherapy*, invited me to contribute a chapter on pain topics.

This opportunity gave me a chance to explore the neuro-immune-endocrine interactions relevant to the human pain experience and discuss the implications for physiotherapy practice. I describe the relevant hormones involved in the stress response, the processes of the immune system that influence pain and neuro-immune plasticity. I introduce the concepts of allostatic load, habituation and dysregulation and frame a discussion of stress and pain around homeostasis. Finally, I propose some clinical implications including the value of investing in a collaborative alliance with patients and promote the application of the Pain and Movement Reasoning Model as a way of engaging with potential influences on pain.

## 2.2 Contributions

| CRediT author statement | |
|---|---|
| Lester E. Jones (90%) | • Conceptualisation<br>• Literature review<br>• Writing – original draft<br>• Writing – review and editing |
| Rhonda Small (5%)<br>(*Primary Supervisor 2014-2016*) | • Writing – review and editing<br>*(below threshold for authorship)* |
| Stephen Kent (5%)<br>*(Co-supervisor 2014-2020)* | • Writing – review and editing<br>*(below threshold for authorship)* |

## 2.3 Published work

**Jones, L. E.** (2017) Stress, pain and recovery: Neuro-immune-endocrine interactions and clinical practice. In: S. B. Porter, editor. *Psychologically Informed Physiotherapy: Embedding Psychosocial Perspectives Within Clinical Management*, pp. 78-106. Edinburgh, UK: Elsevier.

*Permission statement*

This article/chapter was published in Psychologically Informed Physiotherapy: Embedding Psychosocial Perspectives Within Clinical Management, S. Porter (ed), Stress, pain and recovery: Neuro-immune-endocrine interactions and clinical practice, Page Nos 78-106, Copyright Elsevier (2017).

5

# STRESS, PAIN AND RECOVERY

## Neuro-Immune-Endocrine Interactions and Clinical Practice

LESTER E JONES

La Trobe University, Melbourne, Physiotherapy, Allied Health Science, Higher Education MScMed(PM)

CHAPTER CONTENTS

THE BODY'S PROTECTION SYSTEM
Introduction and Overview
Endocrine Control and Stress
*Emotion-Provoked Stress Response*
*The Sympathoadrenomedullary Pathway and Catecholamines*
*The HPA Axis and Cortisol*
Neuroplasticity as an Adaptation for Health
*Activity-Dependent Neuroplasticity*
The Immune System and the Stress Response
*Cytokines*
*Glia Including the Tripartite Synapse*
Allostasis and Allostatic Load
Habituation
Dysregulation
The Effect of Stress on Pain
*Current Concepts of Pain*
*Pain and Neuro-Immune-Endocrine Function*
The Effect of Stress on Healing
APPLICATION IN CLINICAL PRACTICE
Therapeutic Alliance
*Placebo-Like Effects in Clinical Practice*
*Patient-Centred Care*
*Pain and Movement Reasoning Model*
Stress Reducing Interventions and Physiotherapy
*Mindfulness*
*Yoga*
FUTURE DIRECTIONS AND CONCLUSIONS
Future Directions
*Epigenetics*
*The Microbiome*
*Surgical Prehabilitation*
Conclusions

This chapter will explore the effects of psychological and social stressors on the warning system of the body and on the body's capacity to recover from tissue trauma or disease. The opening discussion of the body's capacity to adapt to external and internal stressors – through the integration of neural, immune and endocrine systems – will provide important background to the experimental and clinical evidence of how psychological and social factors modify neuro-immune-endocrine function to influence health.

## THE BODY'S PROTECTION SYSTEM

### Introduction and Overview

The knowledge and understanding of the body's protection system is improving all the time.

*'Only recently have we fully appreciated that the classically separated domains of neurology, endocrinology, immunology and microbiology, with their various organs – the brain, glands, gut, immune cells and microbiota, could actually be joined to each other in a multidirectional network of communication, in order to maintain homoeostasis.'*

***(El Aidy et al., 2014, p. 1)***

The integration of highly evolved systems – the endocrine system, nervous system and immune system – is reflected in innumerable processes essential for the maintenance of homoeostasis (Chapman et al., 2008; El Aidy et al., 2014). The workings of the body's protection system are necessarily complex and a detailed description is beyond the scope of this chapter. However, understanding terminology, processes and responses related to this system when health is challenged is important for physiotherapists.

Integral to discussion about body protection is the stress response. Stress can be described as the condition or situation where the equilibrium of normal functioning of bodily systems or normal cellular functions is threatened (for review see Chrousos, 2009). Importantly factors that threaten normal functioning can be physical, psychological or environmental and so a biopsychosocial framework is important in understanding the effect and response. Fortunately human bodies have a great capacity for adaptation at multiple levels. Recent research into the plasticity of the nervous system – that enables adaptation to injury and modification of physical and cognitive function – suggests that a person has a great ability to adapt to adverse or challenging conditions (Gillick and Zirpel, 2012; Kleim, 2011). Such stress-related plasticity is an adaptive quality with much potential benefit for preserving homoeostasis, including when psychological and social contexts are considered (Deppermann et al., 2014). Also, therapeutic interventions are likely to be enhanced by focusing on how peripherally located interventions might diminish central processing. In particular, how neuro-immune-endocrine communication allows for detection of a threat and the promotion of safety and recovery through peripheral and central mechanisms (Gillick and Zirpel, 2012; Snodgrass et al., 2014).

Although the stress response has a positive effect on preserving homoeostasis, it has the potential to be harmful if normal regulatory processes are inhibited or not functioning (Chrousos, 2009; Liezmann et al., 2012). Dysregulation of the stress response can influence the effectiveness of homeostatic responses (Chrousos, 2009; Deppermann et al., 2014) and there is evidence that psychological and social factors are important in both the perseverance and remediation of the dysfunction (for review see Chapman et al., 2008). The magnitude and especially the chronicity of the stress may also be important with regards to the magnitude of the effect on homoeostasis and health (Kaltsas and Chrousos, 2007). Evidence suggests that early childhood stress, persistent stressful triggers and experience of a major adverse event can all result in negative health outcomes (Chrousos, 2009; Schalinski et al., 2015).

## Endocrine Control and Stress

*'The stress system integrates and responds to a great diversity of distinct circadian, neurosensory, blood borne and limbic signals.'*

***Kaltsas and Chrousos, 2007, p. 305***

Hormones are classified into three groups: (1) steroid hormones – for example cortisol, (2) those derived from tyrosine – for example dopamine, adrenaline and noradrenaline (ie, catecholamines), and (3) peptide and protein hormones – for example oxytocin and vasopressin. They can act systemically or on specific targets and are often involved in feedback loops that inhibit (negative feedback loop) or enhance (positive feedback loop) activity in target tissues. Important endocrine structures include the hypothalamus, pituitary gland and adrenal gland, consisting of two functionally distinct parts – the adrenal cortex and the adrenal medulla. The hypothalamus and pituitary gland are commonly described with the adrenal cortex as the hypothalamic-pituitary-adrenocortical axis (HPA axis). The hypothalamus and pituitary gland are located at the base of the brain above the brainstem and the two adrenal glands are located above each kidney. The locus coeruleus, located in the brainstem (ie, pons), is an important structure for influencing endocrine function. This is because of the connections and influence it has with the so-called emotional centre of the brain, the limbic system (ie, amygdala, hippocampus, hypothalamus, anterior cingulate cortex) (Benarroch, 2009; Samuels and Szabadi, 2008). See Box 5.1 for extra notes on limbic system.

The stress system can be described as having central and peripheral components. Principally, the central components include the nuclei of the hypothalamus, producing corticotrophin-releasing hormone, and the locus coeruleus, a major source of noradrenaline. The peripheral component includes the HPA axis, the end product being cortisol, and the sympatheticoadrenomedullary system (SAM) that produces adrenaline and noradrenaline (Nicolaides et al, 2015).

**BOX 5.1**
**SCEPTICISM OF THE LIMBIC SYSTEM**

It is worth noting that there has recently been some scepticism about the limbic system, from a functional, structural and evolutionary perspective (LeDoux, 2012). It seems clear that the amygdala has an important role in body protection and the stress response, and is structurally complex with many nuclei. However, the assumptions, particularly from animal studies, about its role in emotional responses, may be overstated (for commentary on this see LeDoux, 2012). Convention will prevail for now and the following text will continue to refer to a limbic system that is seen to be involved in communicating emotional input.

The key role of the stress system is to maintain homoeostasis and it relies on communication between brain regions such as the limbic system and locus coeruleus and the integration of nervous, immune and endocrine systems (McEwen et al., 2016). The nervous and immune system are the sentinels for the body's protection system, detecting potential threats and activating the stress system (Grace et al., 2014; Watkins et al., 2007). During a real or perceived threat, endocrine responses alter blood flow and enhance energy availability to ensure that the brain and musculoskeletal system can navigate the person to a more favourable situation (Chrousos, 2009; Nicolaides et al., 2015). This means body functions related to digestion, growth, reproduction and certain aspects of immunity are suppressed at times of stress in order to optimize the use of energy resources required to resolve the situation (for detailed reviews see Kaltsas and Chrousos, 2007 and Nicolaides et al., 2015).

There is also a hypoalgesic effect of acute stress, mediated by β-endorphin which is

released by the pituitary gland (Chapman et al., 2008; Jänig et al., 2006; Melzack, 2005). Beta-endorphin is a powerful analgesic substance that binds to μ-opioid receptors and is released from the pituitary gland as a part of HPA axis activation during times of stress. Intriguingly there is some evidence that the initial effect is not analgesic (Johansen et al., 2003), although there is also some evidence that it has roles in reducing cortisol, substance p (ie, a neuromediator that sensitizes nociceptors) and promoting dopamine levels (ie, pleasure) therefore attenuating the stress response (Melzack, 2005; Sprouse-Blum et al., 2010).

### *Emotion-Provoked Stress Response*

It is very difficult to identify a single starting point of the stress response because of parallel activation and complex feedback systems that trigger and attenuate the various components. Ganzel and colleagues suggest that the activation of the emotional centres is the primary controller of the stress response – and that physiological and behavioural responses are secondary (Ganzel et al., 2010). There is no doubt that the amygdala is well placed for this role with cortical and subcortical connections to stress hormone producers – the hypothalamus and locus coeruleus. Amygdala connections to the prefrontal cortex, hippocampus and anterior cingulate cortex provide potential avenues for activation in response to psychological and social threats (Muscatell et al., 2015; Öhman, 2005).

Interestingly, some novel experiments have investigated how behaviours associated with emotions might modify the stress response. A small study examining laughter found that participants who watched a humorous video had reduced serum cortisol levels compared with controls (Berk et al., 1989). Two studies examining the effects of swearing on pain found that participants who were asked to swear repeatedly during submersion of their hand in icy water had an increased heart rate and were able to keep their hand submerged for longer – suggesting the acute stress response was enhanced (Stephens et al., 2009; Stephens and Umland, 2011).

### *The Sympathoadrenomedullary Pathway and Catecholamines*

A quick and early response to stress occurs via the SAM pathway. Catecholamines are important in the stress response as they act to prepare the body for physical responses through the modification of physiological process, ie, increased heart rate, blood pressure. Adrenaline, noradrenaline and dopamine are all catecholamines. The adrenal medulla is the primary source for adrenaline. Noradrenaline is primarily produced by the sympathetic nervous system and in the brain (ie, the locus coeruleus in the pons). It has multiple roles via its action as a neurotransmitter, primarily in the sympathetic nervous system, and as a hormone. Its effects include increased alertness and vigilance, increased restlessness and anxiety and enhancement of memory and memory retrieval (Berridge et al., 2012; Chrousos, 2009; Watkins and Maier, 2000; Watkins et al., 1995). Dopamine is the precursor molecule for adrenaline and noradrenaline. It has been described as a neuroimmune transmitter (Levite, 2015) because of its role in modulation of immune function via lymphocytes (Buttarelli et al., 2011; Sarkar et al., 2010; Yan et al., 2015). The actions of catecholamines also lead to a reduction in the available

resources needed to repair and maintain tissues, including suppressing the release of proinflammatory cytokines (see following section on 'Cytokines' (or similar)).

### *The HPA Axis and Cortisol*

Corticotropin-releasing-hormone (CRH) is produced by the hypothalamus – and peripheral nerves and immune cells – and triggers the release of adrenocorticotropic hormone (ACTH) from the pituitary gland (Nicolaides et al., 2015). The hormone also acts on the adrenal cortex, modifying gene expression and promoting the synthesis and release of cortisol from the adrenal cortex. Cortisol has many effects on a broad range of tissues in the body. A key action of cortisol is to reduce the production of CRH by the hypothalamus and ACTH by the pituitary gland, therefore completing a negative feedback loop to decrease the HPA axis stress response (Kaltsas and Chrousos, 2007).

Important to this discussion is the influence of cortisol on immune and inflammatory processes (Chrousos, 2009). Cortisol has antiinflammatory and immunosuppressive effects, although some actions are further reliant on intracellular gene transcription factors (Nicolaides et al., 2015). Cortisol also has a role in consolidation of memory (Drexler et al., 2015), presumably by its action on the hippocampus (McEwen et al., 2016). Some of the molecular actions of cortisol initiated by HPA axis activation can take days to complete (see Nicolaides et al., 2015 for a comprehensive review of stress and glucocorticoids).

## Neuroplasticity as an Adaptation for Health

> *'Environmental events and behavioural experience induce epigenetic changes at particular gene loci that help shape neuronal plasticity and function.'*
>
> ***Gold, 2015, p. 37***

The capacity of the nervous system to change has been underestimated for many years. In particular, brain changes – such as those observed in the rehabilitation of stroke survivors – were often attributed to a specific response to disease or tissue damage rather than as part of a normal ongoing process of adaptation (Pomeroy and Tallis, 2002). Other evidence of plasticity has been explained by sensitive phases of growth and development (Trojan and Pokorny, 1999). Arguably this is because the subtle day-to-day adaptations our systems undertake do not attract the same attention as the impressive shift in function and activity required following a neurological event or during transformative periods of growth and development.

It now seems unequivocal that the central nervous system has the capacity to change throughout one's lifespan and that these constant adaptations have a role in homoeostasis (Deppermann et al., 2014; Gillick and Zirpel, 2012). It is apparent that change in synaptic strength and the rate of transmission is responsive to patterns of activity in the elements of the nervous system (Butz et al., 2009; Garland and Howard, 2009; Pittenger and Duman, 2008; Woolf, 2011). The importance of the functional changes seen in the amygdala and hippocampus in response to stress have been written about (McEwen, 2001; 2015), but the role plasticity has in development may also influence the resilience or vulnerability of an individual in response to stressors.

### *Activity-Dependent Neuroplasticity*

Evidence suggests that neuroplasticity can enhance and refine advantageous and life preserving processes through several mechanisms (Butz et al., 2009; McEwen, 2012; Trojan and Pokorny, 1999). It is likely that different mechanisms predominate depending on the context. These contexts might include normal development, including physical, cognitive and emotional development (evolutionary plasticity), development of a new skill or other learning (reactive or adaptive plasticity) and recovery from injury (reparation plasticity) (Trojan and Pokorny, 1999). The general principle across these contexts is that changes to the nervous system are shaped and reinforced by the amount of activity transmitted in neurons and nerve cell bodies (Butz et al., 2009; Trojan and Pokorny, 1999).

Metabolic changes, the concentration of neurotransmitters and populations of receptors at pre- and postsynaptic membranes influence the neural changes that occur and are influenced by proinflammatory and anti-inflammatory substances and other products and mediators of the stress response (Chrousos, 2009; McEwen, 2001; Trojan and Pokorny, 1999). These changes in physiology can be attributed to changes in gene expression. In other words the psychological, environmental and physical experiences trigger nerve activity that in turn lead to changes in genetic influences on neurobiological processes (Garland and Howard, 2009; Wüst et al., 2004). It is also clear that the environmental context and concentration of stress-mediating chemicals can affect the inhibition or enhancement of neurogenesis (for comprehensive reviews see McEwen, 2007 and McEwen et al., 2016).

An important mechanism influencing early development is the systematic reduction in neuronal populations targeting redundant neurons (Casano and Peri, 2015) – that is neurons not involved in the essential activity of the nervous system. This results in the reinforcement of pathways carrying neural activity that is specific to a movement and results in increasingly refined action (Casano and Peri, 2015). Overall this adaptation contributes to the increased precision of essential tasks, such as putting food in your mouth, where neurons that are directly contributing to the desired outcome – hand to mouth – are reinforced and those that create 'noise' to the movement are subject to cell death. In line with this, early life experiences that provide stimulation and appropriate levels of challenge are likely to lead to more adaptive functioning (Boersma et al., 2014; Underwood, 2011).

As we explore this complexity it is clear that focusing on neural plasticity without attention to the adaptations taking place in other systems is inadequate and other terms may capture this better. The term bioplasticity has been used by Moseley and others (Moseley and Butler, 2015), but perhaps neuroimmune plasticity (Rosas-Ballina and Tracey, 2009) or neuroendocrine-immune plasticity (Liezmann et al., 2012) may better represent the processes of interest in this chapter.

## The Immune System and the Stress Response

> *'Physical and psychological stressors activate the same bidirectional immune-brain circuits including autonomic nervous system and hypothalamo-pituitary-adrenal axis.'*
>
> ***Maier and Watkins, 1998,p. 84***

**TABLE 5.1**

**Summary of Key Neuro-Immune-Endocrine Cells and Mediators**

| Type | Key Cells/Mediators | Context | Action |
|---|---|---|---|
| Glucocorticoid | Cortisol | Activated HPA axis | Prepare for fight/flight<br>Reduce inflammation<br>Immunosuppression<br>Consolidate memory |
| Catecholamine | Noradrenaline, adrenaline | Activated SAM pathway | Increase alertness, restlessness<br>Increase heart rate, blood pressure<br>Reduce inflammation<br>Suppress proinflammatory cytokines |
| Glia | Microglia | Internal danger | Detect damage in local environment<br>Prime nervous system<br>Produce cytokines<br>'Memory' for prior threat/danger |
| Proinflammatory cytokine | TNF-α<br>IL-1<br>IL-6 | Cell damage<br>Stressor (acute/chronic) | Stimulate nociceptors<br>Release neuromediators<br>Signalling and communication<br>Induce fever and sickness behaviour |

When the concept of an integrated body protection system is embraced, it makes sense that physical, psychological and social stressors will influence immune function (Ursin, 1994) and that the immune system's activity will influence the stress response (Webster Marketon and Glaser, 2008). Cytokines and glial cells make important contributions to immune function and play a key role in communication between the nervous and immune systems (see Table 5.1 for key neuro-immune-endocrine cells).

### *Cytokines*

Cytokines are peptides that have a primary role in cellular communication in immune-brain function. The roles and interactions of cytokines are complex and consist of anti-inflammatory and proinflammatory types. Released from macrophages and other cells in response to pathogen detection or stress, cytokines are a part of the initial peripheral immune response, activating nociceptors and triggering the release of immune-stimulatory substances, such as substance p, which reciprocally promote cytokine release (see further summary in Chapman et al., 2008 and Sprouse-Blum et al., 2010). The mechanisms of how peripheral immune activation effects brain function is likely to be multimodal. One important mechanism involves the stimulation of intermediary cells by cytokines (especially IL-1) and subsequent transmission of nerve impulses through the sensory components of the vagus nerve (for review see Wrona, 2006). The effects on brain function

are wide ranging, including systemic, behavioural and emotional changes, for example, fever, anorexia, reduced social behaviour and a depressed mood, and are referred to as sickness or an acute-phase response (Kent et al., 1992; Maier and Watkins, 1998). Increased cytokine levels have been associated with changes in both serotonin and dopamine levels (Capuron and Miller, 2011), suggesting a mechanism for the influence on mood, sleep and appetite.

Proinflammatory cytokines include the interleukins IL-1 and IL-6, and tumour necrosis factor-α (TNF-α), and these have a role in activating the HPA axis (Sommer and Kress, 2004; Webster Marketon and Glaser, 2008). As a result, secretion of cytokines can enhance the inflammatory response and also increase levels of cortisol. As previously mentioned, cortisol has antiinflammatory effects. These are a result of binding with the glucocorticoid receptor which alters gene expression in, and interferes with, production of inflammatory cells and compounds (Padgett and Glaser, 2003; Webster Marketon and Glaser, 2008). The advantage the coordination of proinflammatory and antiinflammatory mechanisms has on the stressed organism may be to simultaneously promote alertness and healing, and is reflected in the brain activity of cytokines (Capuron and Miller, 2011). Catecholamines are also reported to modify immune function via β2-adrenergic receptors found on cytokine-producing macrophages (Padgett and Glaser, 2003). This self-limiting process is important to prevent a prolonged inflammatory response that would harm tissues (Austin and Moalem-Taylor, 2010; Stipursky et al, 2011).

**BOX 5.2**
**TOLL-LIKE RECEPTORS**

Toll-like receptors (TLRs) are a critical part of innate immune function and are involved in sensing pathogens and initiating inflammation processes. TLRs are expressed in both immune and nonimmune cell types and have multiple roles including in tissue repair and regeneration after injury (Chang, 2010; Uematsu and Akira, 2007). Higher levels of TLR4 messenger ribonucleic acid (mRNA) are associated with higher levels of inflammation and a low socioeconomic status in childhood and its presence early on appears to lead to higher levels of TLR4 mRNA in later life (Fagundes et al., 2013).

### *Glia Including the Tripartite Synapse*

Glial cells have the capacity to detect and remember chronic danger and are facilitated by toll-like receptors that respond when endogenous danger signalling molecules are detected (see Box 5.2) (Grace et al., 2014). Glial cells include Schwann cells in the periphery and microglia, astrocytes and oligodendrocytes in the central nervous system (Austin and Moalem-Taylor, 2010). Schwann cells produce proinflammatory cytokines and nerve growth factor and have connections with sensory nerves (see review by Thacker et al., 2007). In the central nervous system, the majority of synapses have a structurally and functionally integrated astrocyte. Such synapses are described as tripartite synapses with pre- and post-synaptic terminal, and the glial cell which secretes and regulates neurotransmitter concentrations at the synapse, in particular glutamate and brain-derived neurotropic factor (Milligan and Watkins, 2009; Stipursky et al., 2011). The role of the microglia is still being unravelled. These cells regulate astrocyte responses and probably contribute to synapse efficacy directly (Grace et al., 2014; Milligan and Watkins, 2009) with some suggesting the term tetrapartite –

involving four parts – is a more appropriate description than tripartite (Amantea, 2015). The glial cells' role in regulatory control is important in allostasis as outlined in the following section 'Allostasis and Allostatic Load'.

## Allostasis and Allostatic Load

An important concept in physiological adaptation is allostasis. It has been described as the process of '… achieving stability through change …' (McEwen and Wingfield, 2003, p. 3), which can be distinguished from homoeostasis '… the stability of the physiological processes essential to life …' (McEwen and Wingfield, 2003, p. 3). An interpretation of this is that the body can manage threats that are not symptomatic, but that an enhanced response is required – one that elicits symptoms such as pain – when the threats require a behavioural response to prevent harm and preserve the body's equilibrium. In other words, homoeostasis describes the relatively constant state of the system involving largely predictable cycles of external and internal challenges, where allostasis describes the process of supporting the state of homoeostasis through the management of responses to less predictable challenges and events (Schulz and Vögele, 2015). It is important to note that some authors prefer the term cacostasis rather than allostasis, emphasizing that this is a potentially harmful state (Chrousos, 2009).

The previous discussion on responses to stress may more appropriately be labelled as examples of allostasis. The primary mediators of allostasis include catecholamines and cytokines and the activity of these substances is altered in response to changes and challenges in the psychological, social or physical environments. When these levels are sustained and primary mediators are found to be in excess or inadequate, an individual can be said to be in an allostatic state (McEwen and Wingfield, 2003).

Ganzel and colleagues add to the nomenclature in this area by referring to allostatic accommodation (Ganzel et al., 2010). This is described as the physiological adjustments made, within normal ranges of functioning, in response to a stressor. One feature of this accommodation is the potential that the biological parameters necessary for homoeostasis can to some degree be reset to allow an enhanced response to future stressors. Ganzel and colleagues argue this is in part as a result of psycho-emotional influences such as anticipation, learning and memory (Ganzel et al., 2010). The important notion that this brings to the discussion about the stress response is that the context is always mediating the physiological response to the stressor (Ganzel et al., 2010; Zilioli et al., 2015).

In situations where the stressors are persistent or repeated, allostatic accommodation creates a cumulative effect that effects the individual. This can be described as allostatic load (McEwen and Wingfield, 2003). It can be expected that allostatic load will be increased in situations of poor health, disease, social disconnection and other sustained psychosocial stressors (Juster and McEwen, 2015; Juster et al., 2011). Allostatic overload can be seen as a state of failed adaptation to persistent or fluctuating stressors and can lead to dysregulation of the system (see Fig. 5.1; Mauss et al., 2015).

In clinical practice, allostatic load would seem important to consider, not just with presentations of chronic or persistent symptoms which invariably have complex psychosocial history, but also when considering

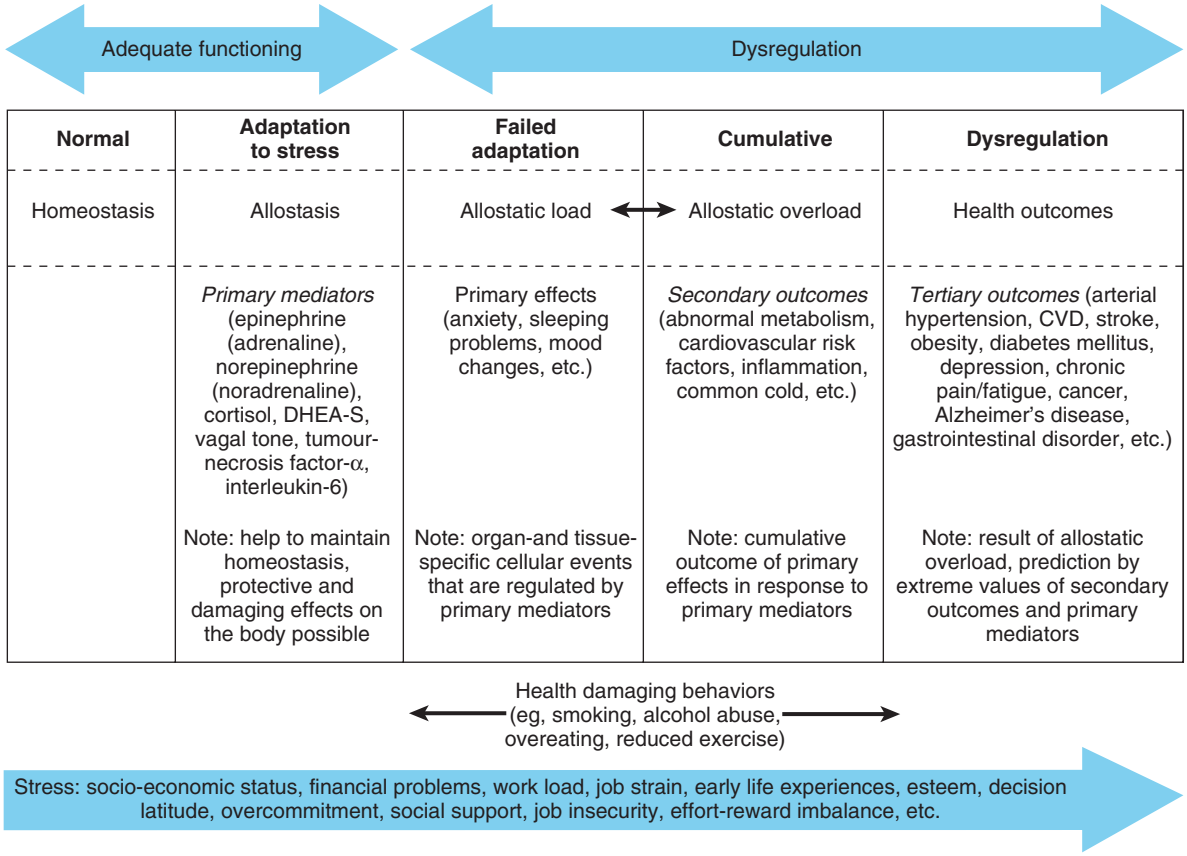


**FIGURE 5.1** ■ Stress regulating process from homoeostasis to allostatic load. *CVD*, cardiovascular disease; *DHEA-S*, Dihydroepiandrosterone sulphate *((Mauss et al., 2015) Psychologically-Informed Physiotherapy.)*

acute presentations. The increased presence of stress and immune mediators may amplify sensitivity of the nervous system and promote a heightened vigilance and response to symptoms that may be out of proportion to the state of the tissues (Grace et al., 2014; Watkins and Maier, 2002). Importantly allostatic load should not be seen as a pathological state, but an increased allostatic load may prime the body's protection system for an enhanced or dysregulated stress response (Ganzel et al., 2010; Grace et al., 2014). Offidani and Ruini (2012) link relevant biomarkers to life events and chronic stressors, recognizing that identifying manifestations of this adversity is important in predicting negative health outcomes.

## Habituation

A common observation during repeated stress (ie, discrete repetitive stressful events) is a reduction in the individual's stress response. This is known as habituation and is presumably helpful in restricting the exposure of tissues to the potentially harmful stress hormones. It is evident in changes in cortisol reactivity and other measures of HPA axis activity (Wüst et al., 2005) and is

also seen in gene expression for inflammatory mediators (McInnis et al., 2015). With mild or short-term stress, this change in reactivity seems to be associated with positive changes to cellular function (Johnstone et al., 2015; Poljšak and Milisav, 2012) and may be described as an acquired cellular resilience akin to acquired immunity (see commentary by Stone, 2016).

However, habituation is not universal and there are some individuals who show no change to repeated exposure. There are also examples of individuals being more sensitive to repeated stress exposure and, although genetic variation cannot be totally ruled out, the effectiveness of the individual's overall response to stress (ie, initially suppressed) is reported to play a role (Wüst et al., 2005). In such situations the characteristics of the stressor seem to be important. These include duration, intensity and frequency and the context of the stressor, including the level of social support (Kudielka and Wüst, 2010; Wüst et al., 2005).

Oxytocin is a neuropeptide that is released both centrally and peripherally and associated with a level of social support (Kudielka and Wüst, 2010). Centrally it is involved in regulating amygdala function and also influences activity in the dorsal horn of the spinal cord where it appears to augment the inhibitory effects of gamma-aminobutyric acid (GABA) (Rash et al., 2014). A recent exploratory study into early life adverse events suggested that oxytocin regulation may be an important adaption to stress with an effect on mood and physical symptoms (Crowley et al., 2015). Social support is said to 'buffer' against stress and promote wound healing and a feature of this is the release of oxytocin which suppresses HPA axis activity (Detillion et al., 2004). In light of this, studies of repeated stress that show stress habituation should always take into account the role of the experimenter's presence and interaction. In clinical interactions, nurturing of the therapeutic alliance between a clinician and the person seeking their care also has the potential to lower stress and this is supported by the link between oxytocin and the level of trust established in such relationships (Benedetti, 2013).

## Dysregulation

It has been proposed that there are four contexts that might lead to dysregulation of the stress system: inability to initiate and sustain an adequate stress response, repeated exposure to stressful stimuli, poor adaption to repeated stressors and an inability to cease an active stress response when a threat has been dealt with (Kaltsas and Chrousos, 2007).

All of these contexts involve the HPA axis and the SAM pathway. Cortisol release can be dysregulated by prolonged HPA axis activation or constant reactivation of the HPA axis. Research into HPA axis activation and markers of inflammation has shown that adults who have had adversity, especially trauma as children, show enhanced responsiveness (Danese and McEwen, 2012; Levine et al., 2015). This is suggestive of an inability to decrease an active response. Paradoxically there can also be reduced cortisol levels when stress responses persist and there is evidence that early adverse life experiences may habituate the stress response so that it is less reactive later in the lifespan (Heim et al., 2000). This might be a reflection of poor adaptation. Although the mechanisms underpinning the

variation in responses are not fully understood, the timing, duration and frequency of adverse events, the individual's resilience or vulnerability and the maturity of the body protection system at the time of the adversity all might play a role (Danese and McEwen, 2012).

Interoception, or the afferent processes that lead to awareness of bodily processes, is important in monitoring threats and is described as having three components: detection, attention and evaluation (Schulz and Vögele, 2015). Stress can lead to dysfunction of interoception, including enhanced or diminished functions (Schulz and Vögele, 2015) and when these components are not operating effectively, the body's protective response will be altered. For example, the increased sensitivity in the detection of physical threats may explain the sensitivity to physical stimuli seen in some people with persistent pain.

Finally there is evidence of dysregulation of neural functioning with chronic stress. Chronic stress is when a person has experienced continual stressful contexts or stressful events over a long period of time. Dysregulation of cognitive and emotional function is affected with altered memory functions and increased reactivity to novel stress (Deppermann et al., 2014; McEwen, 2012). Neuroplasticity may be one mechanism at play with endocrine and immune factors influencing neurogenesis and modification to synapses (Deppermann et al., 2014). Understanding the role of immune and endocrine mediators in neuroplasticity has helped identify specific molecular targets in the search for the treatment of posttraumatic stress disorder (PTSD) (Deppermann et al., 2014).

## The Effect of Stress on Pain

*'By recognizing the role of the stress system in pain processes, we discover that the scope of the puzzle of pain is vastly expanded and new pieces of the puzzle provide valuable clues in our quest to understand chronic pain.'*

***Melzack, 2001, p. 1380***

Biomedical approaches to diagnosis essentially attribute pain to tissue pathology. Increasingly this approach is seen to be flawed as presentations of pain without tissue pathology and evidence of no pain despite tissue pathology is apparent in clinical practice and increasingly in the research literature. Consequently, reframing the meaning of pain is likely to be important. Previously the emphasis has been to interpret a person's pain report as an indicator of the presence and severity of tissue pathology. It may be more appropriate, however, to consider pain as a part of a warning system to protect us from injury or the potential for further damage (Jones, 2007; Moseley, 2007). A patient-centred approach is essential to capture the internal and external influences that might lead to a heightened vigilance for danger and also to identify factors that might make our warning system more sensitive to trigger (Moseley and Butler, 2015). In this section this reframed view of pain will be explored in the context of stress biology, drawing on the concept of allostatic load to identify how pain may be influenced by past experiences and how pain at times of stress may be enhanced and prolonged. See to Box 5.3 for extra notes on pain and inflammation.

The early work of Gifford, in particular the 'Mature Organism Model', is an important influence on these ideas (see Gifford, 1998) as

**BOX 5.3**
**THE ROLE OF INFLAMMATION IN PAIN AND HEALING**

Although patients often are concerned about the signs of inflammation, it is an essential component of recovery from tissue injury. Activated mast cells release products that promote swelling at the site of injury and the collection of fluid contains inflammatory mediators that make the area sensitive by either triggering nociceptors or reducing the threshold for the transmission of danger signals (Diegelmann and Evans, 2004). Cytokines, including interleukins and TNF-α, have important roles in coordinating the inflammatory phase of healing, including the chemical influences on nociceptor activation, transmission and sensitivity (Diegelmann and Evans, 2004; Schaible et al., 2011). Therefore the influence of stress on cytokine activity – and other inflammatory mediators – is significant in clinical presentations of pain and tissue healing.

are the informed reflections on persistent pain by Zusman (see Zusman, 2008; 2012; 2013).

### *Current Concepts of Pain*

> *'Central to understanding interpersonal features of pain is recognition that pain typically is experienced in complex social environments, with the person's distress manifestly obvious, often predicated upon the social setting, and reactions of others.'*
>
> ***Hadjistavropoulos et al., 2011, p. 912***

It is now well established that pain is influenced and determined by multiple internal and external factors, yet there remains a focus on biomedical factors in much of current health practice (Briggs et al., 2013; Parsons et al., 2007; Zusman, 2013). Traditionally one factor, tissue damage, has been seen as the most important feature to explain a person's pain. This makes sense as it is common experience to sustain tissue damage and feel pain. However, there are two things that need to be reflected upon. First, research over the last two decades has demonstrated there is a mismatch between evidence of pathoanatomical changes and pain (Girish et al., 2011; Ho-Joong Kim et al., 2013; Husarik et al., 2010; Jensen et al., 1994; Nakashima et al., 2015; Nardo et al., 2015; Sher et al., 1995; Stehling et al., 2010). Second, many persistent pain presentations cannot be attributed to any pathological tissue source (Zusman, 2012); see also the discussion on 'modern health worries' in Baliatsas et al. (2015). Integration of a biopsychosocial approach into clinical practice can help explain much of the evidence that conflicts with a tissue-based approach and was elegantly introduced to physiotherapy in a review article more than 20 years ago (Moffett and Richardson, 1995). What can be added to those early thoughts is the contemporary knowledge of psychoneuroimmunology.

### *Pain and Neuro-Immune-Endocrine Function*

Cytokines have an important role in modulating the pain experience, including linking the immune and nervous system through an interplay with glial cells (McMahon et al., 2005; Sommer and Kress, 2004; Watkins and Maier, 2005). TNF-α, a proinflammatory cytokine, has a role in triggering the release of other cytokines and has an effect on a range of tissues centrally and peripherally (for reviews see Capuron and Miller, 2011; Sommer and Kress, 2004). Peripheral effects include activating and sensitizing nociceptors – the body's neural sensors of dangerous chemical, mechanical and thermal stimuli. There is evidence that this can occur directly – that is, exposure of the free nerve ending to

cytokines such as TNF-α – or indirectly – via other mediators or gene transcription (Capuron and Miller, 2011; Sommer and Kress, 2004). As mentioned previously, the proinflammatory cytokines also have a role in activating the HPA axis that stimulates the release of cortisol from the adrenal cortex (Capuron and Miller, 2011). This molecular link between the warning signal (ie, pain) and the stress response is understandable when considering pain as a part of the body protection response.

There are established links between dysregulation of the HPA axis – both hypercortisolism and hypocortisolism – and various pain-related conditions including fibromyalgia and rheumatoid arthritis (Chrousos, 2009). Supporting evidence includes a group of interesting studies looking at the role of exercise, β-endorphin, pain and cortisol, which have determined a mediating factor to be low mood (Chatzitheodorou et al., 2007; 2008; Harte et al., 1995; Hoeger Bement et al., 2010).

The cognitive process of rumination, or persistent negative thinking about past experience, has been linked to increased cortisol reactivity, an indication of hyperactivation of the HPA axis (Zoccola et al., 2010 and see detailed review by Zoccola and Dickerson, 2012). This makes sense, as cortisol enhances memory in terms of events, which is believed to be an evolved strategy for survival. Cortisol via hippocampal processes has also been shown to consolidate pain-related memory when the memory is reactivated – including rumination – although this may be only in the context of an anxious state (Ploghaus et al., 2001). In sum, memory of situations that are potentially dangerous will allow for early response to, or, perhaps more importantly, avoidance of, a future threat and this is especially so when the threat is recurrent.

Rumination, along with magnification and helplessness, is a feature of the psychological concept of catastrophizing. The attention-promoting effects of cortisol may promote catastrophizing (Crombez et al., 2004; Eccleston et al., 2004; Quartana et al., 2010). Catastrophizing is strongly linked to the human pain experience and shown to influence pain intensity, persistence and pain-related disability (Coronado et al., 2015; Crombez et al., 1998; Keefe et al., 2010; Khan et al., 2011; Vervoort et al., 2006). A strong social component may exist with this link, although a well-designed experimental study suggests pain-related fear might influence pain ratings more than catastrophizing (Hirsh et al., 2008). This is notable as a recent prospective study could not identify a biomarker link between dysregulated stress, childhood adverse life experiences and the development of multisite pain (Generaal et al., 2015). Pain-related fear and catastrophizing were not measured however, and the authors concluded that the link between adverse childhood experiences and multisite pain may be mediated by psychological factors (Generaal et al., 2015).

There has also been some variation in results from studies investigating immune biomarkers and pain severity. A study of immune activity during back pain confirmed there was an inflammatory process following intervertebral disc herniation but found that the levels of interleukins (IL-1β and IL-6) did not distinguish pain >3.5 on a visual analogue scale (VAS) versus pain less than 3.5 (Andrade et al., 2013). In contrast, another

study, again involving participants with disc herniation, showed that more than 3 on a VAS was associated with IL-6 and IL-8 at 12 months postsurgical repair (Pedersen et al., 2015). Of interest, recurrent herniation has been found to be associated with an increase in the cytokine TNF-α and the concentration of its receptor TNFR1 (Andrade et al., 2016). This variation fits with current concepts of pain and reflects the need for multidimensional assessment and treatment.

## The Effect of Stress on Healing

> '…*psychological stress impairs normal cell-mediated immunity at the wound site, causing a significant delay in the healing process.*'
>
> ***Godbout and Glaser, 2006, p. 243***

Wound healing can be affected by local and systemic factors (Khalil et al., 2015). Psychological and social circumstances may affect local factors such as the protection of the wound, promotion of optimal tissue conditions for healing and the risk of infection. For example, where someone is unable to stop work because of job security or financial concerns, they are more at risk of compromising the healing process. As well, if the mental health of a person leads them to neglect self-care, then again the ideal conditions for healing may not be preserved. The link between psychological and social factors in these examples is essentially behavioural – that is, the person's inadequate behavioural response to injury affects healing. These have been labelled as 'health-impairing behaviours' (Boyapati and Wang, 2007).

There has been substantial experimental research investigating more indirect influences of psychological and social factors on healing, for example the levels of cortisol and cytokine production. These could be described collectively as systemic effects and involve the influence of characteristics such as age, gender, nutrition, chronic diseases and psychological and social stress. Research has examined the effect of exercise on healing in older men after they were given a skin lesion to the back of the nondominant hand (Emery et al., 2005), the effect of examination stress on healing of experimentally applied oral lesions (Marucha et al., 1998), the effect of hostile marital interactions (Kiecolt-Glaser et al., 2005) and the effect of anger control on the healing of experiment-induced blistering (Gouin et al., 2008).

The general outcomes from these studies have been that a broad range of stressors can raise cortisol, reduce the activity of proinflammatory cytokines and therefore delay healing (Godbout and Glaser, 2006). As well, relationships have been established between perceived stress, self-reported general health and healing rate (Ebrecht et al., 2004) and, interestingly, a positive association between healing rate and writing about distressing events, probably mediated by sleep (Koschwanez et al., 2013). The role of exercise on healing is likely to be multifactorial, including mediating psychological stress and improving perfusion of tissues (Emery et al., 2005). The outcomes from this research necessitates health professionals to acknowledge the role of psychological and social factors on tissue recovery, and therefore promotes the need to consider strategies – within their scope of practice – that optimize the healing environment.

## APPLICATION IN CLINICAL PRACTICE

### Therapeutic Alliance

> *'…you can't get anywhere unless you know, and the patient knows, it is safe to proceed…'*
>
> ***Gifford, 2014***

The term 'therapeutic alliance' captures the partnership between a therapist and the client and can be described as collaborative and involving trust and empathy. It has been shown to positively influence treatment outcomes (Pinto et al., 2012) and some of the psychoneuroimmunoendocrinology issues are discussed in the following sections.

#### *Placebo-Like Effects in Clinical Practice*

> *'The mere ritual of the therapeutic act may generate therapeutic responses through the patient's expectations and beliefs (placebo responses), which sometimes may be as powerful as those generated by real medical treatments. Today, these placebo responses can be approached from a biological perspective, whereby the biochemical, anatomical, and physiological link between expectation.'*
>
> ***Benedetti, 2013, p. 1213***

The contributions to the placebo response include a supportive therapeutic relationship, contextual factors including environmental aspects associated with recovery (ie, conditioning), expectations and the psychological responsiveness of the patient and the severity of the symptoms (Benedetti, 2013; Finniss et al., 2010). It would seem appropriate to reserve the term placebo for experimental and clinical trials as it often requires an element of concealment. Ethically there is no place for deception in clinical practice. It is accepted, however, that the influences and mechanisms will be present in placebo-like effects in clinical interventions. Exploiting the knowledge of these nonspecific treatment benefits would seem appropriate and give support to the importance of a healthy therapeutic alliance and of educating the patient about the great healing powers that the body possesses.

The current knowledge of the underpinning psychoneuroimmunoendocrinology for placebo-like responses has been well described (Benedetti, 2013). This includes a detailed review of the steps involved in health professional–patient interaction. First the patient needs to feel she or he is unwell, which is triggered by cytokine activity (Watkins and Maier, 2005). Then there is a need to seek relief and this involves a positive expectation that might reduce stress when action is taken (eg, arrive at the doctor's and start to feel better). Meeting the health professional can have a profound influence over activity in the amygdala (ie, fear and emotion promoting stress), mediated by oxytocin and the level of trustworthiness the patient perceives in the health professional's appearance and manner (Benedetti, 2013). The language used and empathy of the health professional also influences the neuro-immune-endocrine mechanisms that might be triggered (Benedetti, 2013). For example, there is now impressive evidence that imaging reports can alter outcomes (Jarvik et al., 2015) and a potential mechanism for this is increased anxiety and elements of catastrophizing, resulting in HPA axis activation and catecholamine activity.

### *Patient-Centred Care*

Patient-centred care is a key feature of a positive therapeutic alliance (Pinto et al., 2012). Patient-centred care is respectful of a person's values and needs, and works towards goals that are reflective of the person's preferences and expectations (Hoffmann and Tooth, 2009). A key principle of patient-centred care is to make the person feel safe. This requires good interpersonal skills, well-targeted education and may involve shared-decision making (Hoffmann and Tooth, 2009). When the physiotherapist engages in this way with the person they are treating, they are creating a safe space that should reduce stress, and therefore reduce pain and enhance healing.

One small qualitative study captured the perspective of the patient involved in the clinical interaction and identified five health professional characteristics that were valued: good communication, confidence, knowledge and professionalism, ability to relate to and understand people, and transparency with information about clinical progression and outcomes (Kidd et al., 2011). This reflects the need for a respectful interaction that makes the person feel safe and builds trust and it would be expected that these elements would facilitate placebo-like responses in association with the person's treatment.

Another exploratory study identified what strategies nursing staff used to facilitate patient-centred care including promoting shared decision making, promoting meaningful, enjoyable and pleasurable living and valuing people through engagement with their life story (Edvardsson et al., 2013). A patient-centred approach demands an emphasis on the person beyond the affected body part or the presenting condition.

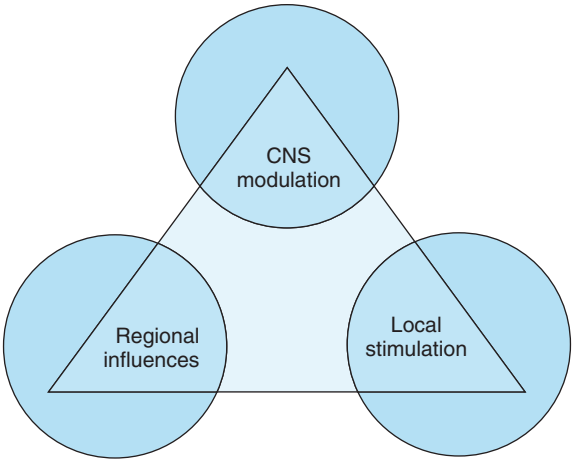


**FIGURE 5.2** ■ The pain and movement reasoning model categories – local stimulation, regional influences, central modulation (Jones and O'Shaughnessy, 2014). *('Pain and movement reasoning model' by Des O'Shaughnessy and Lester Jones is licensed under a Creative Commons Attribution-NonCommercial 3.0 Unported License.)*

### *Pain and Movement Reasoning Model*

> *'Pain perception takes place in a context of an individual's environment, including the physical, social and emotional contexts, and then is managed in a clinical context influenced by the values and beliefs of the therapist.'*
>
> ***Jones and O'Shaughnessy, 2014, p. 270***

For assessment to be patient-centred it needs to incorporate psychological, emotional and social factors and current and past history. The pain and movement reasoning model is a clinical reasoning tool that was designed to capture the complexity of pain by categorizing the range of pain mechanisms (Jones and O'Shaughnessy, 2014) (see Figure 5.2). The three categories include mechanisms that trigger or sensitize the nociceptors (ie, local stimulation), mechanisms that contribute to the pain but are remote to the location of pain (ie, regional influences) and mechanisms

that alter the processing of pain in the spinal cord or brain (ie, central modulation). Although the local stimulation and regional influences categories explicitly incorporate neuro-immune interactions, the central modulation incorporates shared neuro-immune-endocrine mechanisms, influenced by psychological, emotional and social factors that are involved in both pain and stress. This includes the sensitivity to pain and stress that has been associated with early or persistent stressors across time, as well as the effect of current cognitive strategies (eg, rumination), mood (eg, anger or depression) and emotions (eg, fear or loneliness). When using the model as a clinical reasoning tool, it is expected that the clinician engage with all categories – and therefore all the potential influences of pain – and this demands an extension of assessment beyond traditional pathoanatomical approaches (Jones and O'Shaughnessy, 2014).

The 'central modulation' category of the pain and movement reasoning model allows the moderators and mediators of pain to be captured in the assessment and clinical reasoning process. Moderators can be considered to be factors that preexist yet influence subsequent signs and symptoms of an intervention or event (Turner et al., 2007). An example would be if someone has had early life traumatic experiences (moderator) then the pain of an injury may be enhanced as a result of sensitized neuro-immune processes (Fleischman et al., 2014). Or equally, if someone has persistent back pain (moderator) and gets an infection that enhances neuro-immune activity, the back pain might become worse (Grace et al., 2014). Mediators are factors that accompany or are subsequent to an event and modify the effect and outcomes of the event (Turner et al., 2007). For example, if someone becomes concerned after reading the imaging report (mediator) of their spine, then they may magnify and ruminate on potential negative outcomes leading to heightened HPA axis activity (Gianferante et al., 2014; Jarvik et al., 2015; Webster and Cifuentes, 2010). Or if someone is unable to sleep because their pain is poorly controlled, then allostatic load might be increased and the person may become even more sensitive to movement (Juster and McEwen, 2015). Importantly, if someone had poor sleep hygiene before an injury it could be considered a moderator as a result of the bidirectional effects of sleep and pain (Straube and Heesen, 2015). Disrupted sleep contributes to allostatic load suggesting the sleep deprived person is primed for activation of the body's protection system (McEwen and Karatsoreos, 2015).

After exploring the categories of the pain and movement reasoning model the clinician is able to come up with a formulation. Formulation is a term from psychology practice which can be described as the clinician's hypotheses about the causes and influences of the person's problem, and incorporates relevant theoretical knowledge (Johnstone and Dallos, 2013). It may be useful to consider it as a step before diagnosis and planning of treatment, when the clinician uses her/his expertise to reflect on assessment findings. The model promotes a formulation process that integrates current concepts of pain and neuro-immune function within a biopsychosocial framework (Jones and O'Shaughnessy, 2014). Physiotherapists can then make decisions about treatment priorities and the need for incorporating experts from other disciplines.

Arguably this broad assessment of the person, that enables the moderators and mediators of the pain experience to be captured, promotes an enhanced interaction between the person and the health professional. Recognizing a role for neuro-immune-endocrine interactions in pain, facilitates a greater number of treatment targets including social, psychological, biomechanical and biomedical. Valuing the person's life story then allows for contextually appropriate interventions. See Box 5.4 for a brief caution when adopting this approach.

## Stress Reducing Interventions and Physiotherapy

Research has shown promising results for a range of interventions that collectively can be considered to target stress and the stress response, and which have increasing relevance for physiotherapy practice that seeks to incorporate mind-body strategies. The research supporting mindfulness and yoga will be looked at in some detail but research also supports other interventions including Feldenkrais (Hillier and Worley, 2015), Tai Chi (Robert-McComb et al., 2015) and hypnosis (Jensen et al., 2015). Shared components of these contemplative techniques can include cultivating body awareness (interoception), controlled and mindful movement, present awareness through the focus on breathing, learning to take effective action (empowerment) and social safety.

As confidence grows in the importance of the integration of neuro-immune and endocrine systems on health, mind-body interventions such as these that regulate the stress response may increasingly be recommended as preventative strategies.

Other areas that have potential to modify psychoneuroimmunoendocrinological factors include musical activities, with some evidence supporting benefits of group drumming, group singing, passive listening to relaxing music (Chanda and Levitin, 2013) and intensive experiences in natural settings like the concept of 'forest bathing' (Mao, Cao et al., 2012). It would be reasonable to think that these relatively economical, accessible and available experiences could be a feature of future psychologically informed health care.

### *Mindfulness*

Mindfulness probably has the broadest acceptance of these interventions and has been defined as:

> *'…the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgementally to the unfolding of experience moment by moment.'*
>
> ***Kabat-Zinn, 2003, p. 145***

Research has demonstrated that mindfulness training can reduce levels of inflammatory biomarkers (eg, IL-6, c-reactive protein) across populations as diverse as lonely older adults, unemployed job seekers, people with

**BOX 5.4**
**RISK OF IATROGENIC OUTCOMES WHEN EXTENDING SCOPE**

It is important to recognize that extending assessment or treatment into the realm of mind-body integration has risks. An untrained clinician can do great harm to someone who is vulnerable as a result of prior trauma. Care must be taken to ensure that health professionals are clear on their scope of practice and are aware of the consequences of confronting clients – intentionally or unintentionally – with past traumatic experiences.

advanced cancer and their caregivers and women who have experienced interpersonal trauma (Creswell et al., 2012; 2016; Gallegos et al., 2015; Lengacher et al., 2012). A reduction in cortisol, associated with a reduction in stress measures, has also been documented (Lengacher et al., 2012), but not consistently (Cash et al., 2015). Although mindfulness and immunity studies have been criticized methodologically, including that the measurement of inflammatory biomarkers is generally incorporated as a secondary and not primary outcome (Black and Slavich, 2016), mindfulness also seems to be associated with improvements in relevant psychological measures of anxiety, depression, loneliness, stress and emotional-regulation (Cash et al., 2015; Creswell et al., 2012; Gallegos et al., 2015).

Mindfulness has also been incorporated into management for people with pain conditions. A study investigated the effect of mindfulness training in women with fibromyalgia and, although it did not report improvements in pain or physical function, fatigue and sleep were both improved (Cash et al., 2015). Other research has found a reduction in pain outcomes including pain intensity (Brotto et al., 2015; Reiner et al., 2013). The effects of mindfulness on cognitive variables like anxiety, attention and catastrophizing may provide some explanation for the changes in pain perception.

A repeated commentary in the mindfulness literature suggests that the quality and quantity of training affects the level of mindfulness that is achieved, the change that occurs in other variables (eg, psychological measures and inflammatory biomarkers) and the sustainability of effect.

### *Yoga*

Interventions incorporating yoga have increasing research support for the treatment of pain (Tekur et al., 2012; Ward et al., 2013) and reduction of stress and anxiety (Kiecolt-Glaser et al., 2010; Sharma and Knowlden, 2012). Mechanisms of how yoga interventions improve pain and stress outcomes are not entirely understood, but key aspects may be an enhanced positive affect, and the cultivation of self-compassion and mindfulness (see the following reviews by Riley and Park, 2015 and Ward et al., 2013). Increasingly studies are measuring changes in stress hormones and other markers to identify the mechanisms and effects. For example, in a study that included novices and experts in the practice of yoga, the experts had significantly lower biological markers for inflammation (ie, IL-6) (Kiecolt-Glaser et al., 2010).

There are more clinical based studies too. Depressive illnesses have been associated with a dysregulated stress response (for a comprehensive review see Gold, 2015) and an intensive yoga intervention for people with depression was found to improve depression, state and trait anxiety scores (Tekur et al., 2012). The study location was a city in India where yoga practice is arguably more common and acceptable, and so these findings may not be generalizable to other cultural contexts. However, a reduction in depression was also achieved in a randomized control trial of a yoga intervention in American women with PTSD, and sustained in those women who continued their yoga practice at 18 months' follow-up (Rhodes et al., 2016). PTSD symptoms were also reduced. An 8-week yoga intervention improved cortisol levels in women with fibromyalgia, a condition that

has been associated with hypocortisolism (Curtis et al., 2011). Studies that have investigated yoga interventions for preventing and controlling type 2 diabetes – a condition associated with hypercortisolism – have also shown promising outcomes (Sharma and Knowlden, 2012). Promising results have also been reported for using yoga and aerobic exercise to reduce stress in people with schizophrenia, although the lack of physiological measures for stress and a large dropout rate reduce confidence in these results (Vancampfort et al., 2011).

As with mindfulness, the research would suggest that those who persist with a regular yoga practice are the most likely to show health and wellbeing benefits (Rhodes et al., 2016).

## FUTURE DIRECTIONS AND CONCLUSIONS

### Future Directions

#### *Epigenetics*

> *'…development never ends and adolescents, young adults, mature and aging individuals continue to show the results of experiences, including opportunities for redirection of unhealthy tendencies through a variety of interventions.'*
>
> ***McEwen et al, 2015, p. 7***

Epigenetics is a growing area of research, investigating factors that alter gene transcription and expression without changing the gene sequence (Feil and Fraga, 2012). It seems apparent that environmental influences have an effect on gene expression during gestation and throughout the lifespan (Feil, 2006; Feil and Fraga, 2012; Radley et al., 2011). Some change can be short term, whereas other modifications can be long lasting with potential effects on susceptibility or resilience to disease (Klengel and Binder, 2015; Zannas and West, 2014).

There are a number of reviews that have looked at the role of epigenetics on the body's protection responses such as stress (Radley et al., 2011) and pain (Stone and Szyf, 2013) and some of the mechanisms have been described earlier in this chapter. The importance of the interaction of neuro-immune-endocrine activity, environmental and psychological factors , and gene expression is still being unravelled. As the mechanisms become clearer, however, there is potential to better explain health outcomes including susceptibility and resilience to chronic conditions (Klengel and Binder, 2015; Lirk et al., 2015; Zannas and West, 2014).

#### *The Microbiome*

> *'…organisms within the gut play a role in early programming and later responsivity of the stress system'.*
>
> ***Moloney et al., 2014, p. 49***

The interaction between the nervous system and our microbial population is an exciting and potentially revolutionary area of research. It is becoming apparent that homoeostasis relies on appropriate communication between the central nervous system and the gut microbiota and disease risk is heightened when there is dysregulation of these processes (El Aidy et al., 2014; Moloney et al., 2014; Sun and Chang, 2014). The links between the central nervous system, the autonomic nervous system and the enteric nervous system, underpin neural communication,

with the vagus nerve providing the pathway for bidirectional communication between the gut and brain (Moloney et al., 2014). The comparisons with the immune system's role in stress, and indeed pain, are apparent and there is growing evidence of brain-gut immune disruption and autonomic dysregulation in irritable bowel syndrome (Elsenbruch, 2011; Phillips et al., 2014), and associations with other inflammatory and pain conditions (Woolf, 2011). Links between gut dysfunction and mood and behaviour change reinforce that this will be an important area to monitor in the future (El Aidy et al., 2014; Kaplan et al, 2015; Logan, 2015; Sun and Chang, 2014).

### *Surgical Prehabilitation*

Another area that is likely to develop in the future is an enhanced surgical prehabilitation that recognizes the role of neuro-immune-endocrine factors on healing and pain. Authors in this field have flagged the need for building 'physiological reserve', including attention to nutrition and psychological factors (Carli and Scheede-Bergdahl, 2015). Katz and colleagues have developed a sophisticated approach to the management of pain associated with surgery (Katz et al., 2015). By considering the risks at various stages – pre-operative, intraoperative and postoperative – they created optimal and timely interventions to improve pain outcomes. This included assessing for mood and catastrophizing early, monitoring of adverse surgical outcomes like nerve damage or inflammation and reviewing for characteristics of PTSD in the longer term (Katz et al., 2015). This sophisticated approach to pain assessment and treatment could be seen as an application of psychoneuroimmunoendocrinology and would seem to be an important example for future practice.

## Conclusions

It is clear that it is no longer appropriate to employ unsophisticated single system approaches to clinical practice. A persistence with purely pathoanatomical models of physiotherapy will be detrimental not only to patients, but also to the profession's future growth. This chapter has attempted to provide an overview of stress biology using an integrated systems approach. By considering the body's protection system as the integration of neural, immune and endocrine systems, the complexity of many clinical presentations can be better understood. This includes the role of personal and environmental factors and the effects of prior adverse life events on pain and healing. It also emphasizes the benefits of patient-centred care, not only to capture the person's story and potential influence on health, but also to create a safe therapeutic interaction that facilitates health-promoting neuro-immune-endocrine responses. Taking a psychologically informed, or even a psychoneuroimmunoendocrinologically informed, approach to physiotherapy recognizes the power of the clinical interaction to influence health on multiple levels.

## References

Amantea, D., 2015. Editorial overview: Neuroscience: Brain and immunity: new targets for neuroprotection. Current Opinion in Pharmacology 26, v–viii.

Andrade, P., Hoogland, G., Garcia, M.A., Steinbusch, H.W., Daemen, M.A., Visser-Vandewalle, V., 2013. Elevated IL-1β and IL-6 levels in lumbar herniated discs in patients with sciatic pain. Eur. Spine J. 22, 714–720.

Andrade, P., Hoogland, G., Teernstra, O.P., Van Aalst, J., Van Maren, E., Daemen, M.A., et al., 2016. Elevated levels of

tumor necrosis factor-α and TNFR1 in recurrent herniated lumbar discs correlate with chronicity of postoperative sciatic pain. Spine J. *16*, 243–251.

Austin, P.J., Moalem-Taylor, G., 2010. The neuro-immune balance in neuropathic pain: Involvement of inflammatory immune cells, immune-like glial cells and cytokines. J. Neuroimmunol. 229, 26–50.

Baliatsas, C., Van Kamp, I., Hooiveld, M., Lebret, E., Yzermans, J., 2015. The relationship of modern health worries to non-specific physical symptoms and perceived environmental sensitivity: A study combining self-reported and general practice data. J. Psychosom. Res. 79, 355–361.

Benarroch, E.E., 2009. The locus coeruleus norepinephrine system Functional organization and potential clinical significance. Neurology 73, 1699–1704.

Benedetti, F., 2013. Placebo and the new physiology of the doctor-patient relationship. Physiol. Rev. 93, 1207–1246.

Berk, L.S., Tan, S.A., Fry, W.F., Napier, B.J., Lee, J.W., Hubbard, R.W., et al., 1989. Neuroendocrine and stress hormone changes during mirthful laughter. Am. J. Med. Sci. 298, 390–396.

Berridge, C.W., Schmeichel, B.E., España, R.A., 2012. Noradrenergic modulation of wakefulness/arousal. Sleep Med. Rev. 16, 187–197.

Black, D.S., Slavich, G.M., 2016. Mindfulness meditation and the immune system: a systematic review of randomized controlled trials. Ann. N. Y. Acad. Sci. 1373, 13–24.

Boersma, G., Bale, T., Casanello, P., Lara, H., Lucion, A., Suchecki, D., et al., 2014. Long-Term Impact of Early Life Events on Physiology and Behaviour. J. Neuroendocrinol. 26, 587–602.

Boyapati, L., Wang, H.L., 2007. The role of stress in periodontal disease and wound healing. Periodontol. 2000 44, 195–210.

Briggs, A.M., Slater, H., Smith, A.J., Parkin-Smith, G.F., Watkins, K., Chua, J., 2013. Low back pain-related beliefs and likely practice behaviours among final-year cross-discipline health students. Eur. J. Pain 17, 766–775.

Brotto, L.A., Basson, R., Smith, K.B., Driscoll, M., Sadownik, L., 2015. Mindfulness-based group therapy for women with provoked vestibulodynia. Mindfulness 6, 417–432.

Buttarelli, F.R., Fanciulli, A., Pellicano, C., Pontieri, F.E., 2011. The dopaminergic system in peripheral blood lymphocytes: from physiology to pharmacology and potential applications to neuropsychiatric disorders. Curr. Neuropharmacol. 9, 278.

Butz, M., Wörgötter, F., Van Ooyen, A., 2009. Activity-dependent structural plasticity. Brain Res. Rev. 60, 287.

Capuron, L., Miller, A.H., 2011. Immune system to brain signaling: neuropsychopharmacological implications. Pharmacol. Ther. 130, 226–238.

Carli, F., Scheede-Bergdahl, C., 2015. Prehabilitation to enhance perioperative care. Anesthesiol. Clin. 33, 17–33.

Casano, A.M., Peri, F., 2015. Microglia: Multitasking Specialists of the Brain. Dev. Cell 32, 469–477.

Cash, E., Salmon, P., Weissbecker, I., Rebholz, W.N., Bayley-Veloso, R., Zimmaro, L.A., et al., 2015. Mindfulness meditation alleviates fibromyalgia symptoms in women: Results of a randomized clinical trial. Anns Behav. Med. 49, 319–330.

Chanda, M.L., Levitin, D.J., 2013. The neurochemistry of music. Trends Cogn. Sci. 17, 179–193.

Chang, Z., 2010. Important aspects of Toll-like receptors, ligands and their signaling pathways. Inflamm. Res. 59, 791–808.

Chapman, C.R., Tuckett, R.P., Song, C.W., 2008. Pain and stress in a systems perspective: reciprocal neural, endocrine, and immune interactions. J. Pain 9, 122–145.

Chatzitheodorou, D., Kabitsis, C., Malliou, P., Mougios, V., 2007. A pilot study of the effects of high-intensity aerobic exercise versus passive interventions on pain, disability, psychological strain, and serum cortisol concentrations in people with chronic low back pain. Phys. Ther. 87, 304–312.

Chatzitheodorou, D., Mavromoustakos, S., Milioti, S., 2008. The effect of exercise on adrenocortical responsiveness of patients with chronic low back pain, controlled for psychological strain. Clin. Rehabil. 22, 319–328.

Chrousos, G.P., 2009. Stress and disorders of the stress system. Nat. Rev. Endocrinol. 5, 374–381.

Coronado, R.A., George, S.Z., Devin, C.J., Wegener, S.T., Archer, K.R., 2015. Pain sensitivity and pain catastrophizing are associated with persistent pain and disability after lumbar spine surgery. Arch. Phys. Med. Rehabil. 96, 1763–1770.

Creswell, J.D., Irwin, M.R., Burklund, L.J., Lieberman, M.D., Arevalo, J.M., Ma, J., et al., 2012. Mindfulness-based stress reduction training reduces loneliness and pro-inflammatory gene expression in older adults: a small randomized controlled trial. Brain Behav. Immun. 26, 1095–1101.

Creswell, J.D., Taren, A.A., Lindsay, E.K., Greco, C.M., Gianaros, P.J., Fairgrieve, A., et al. In Press. Alterations in resting state functional connectivity link mindfulness meditation with reduced interleukin-6: a randomized controlled trial. Biol. Psychiatry 80, 53–61.

Crombez, G., Eccleston, C., Baeyens, F., Eelen, P., 1998. When somatic information threatens, catastrophic thinking enhances attentional interference. Pain 75, 187–198.

Crombez, G., Eccleston, C., Van Den Broeck, A., Goubert, L., Van Houdenhove, B., 2004. Hypervigilance to pain in fibromyalgia: the mediating role of pain intensity and catastrophic thinking about pain. Clin. J. Pain 20, 98–102.

Crowley, S.K., Pedersen, C.A., Leserman, J., Girdler, S.S., 2015. The influence of early life sexual abuse on oxytocin concentrations and premenstrual symptomatology in women with a menstrually related mood disorder. Biol. Psychol. 109, 1–9.

Curtis, K., Osadchuk, A., Katz, J., 2011. An eight-week yoga intervention is associated with improvements in pain, psychological functioning and mindfulness, and changes in cortisol levels in women with fibromyalgia. J. Pain Res. 4, 189–201.

Danese, A., McEwen, B.S., 2012. Adverse childhood experiences, allostasis, allostatic load, and age-related disease. Physiol. Behav. 106, 29–39.

Deppermann, S., Storchak, H., Fallgatter, A.J., Ehlis, A.-C., 2014. Stress-induced neuroplasticity: (Mal)adaptation to adverse life events in patients with PTSD–A critical overview. Neuroscience 283, 166–177.

Detillion, C.E., Craft, T.K., Glasper, E.R., Prendergast, B.J., Devries, A.C., 2004. Social facilitation of wound healing. Psychoneuroendocrinology 29, 1004–1011.

Diegelmann, R.F., Evans, M.C., 2004. Wound healing: an overview of acute, fibrotic and delayed healing. Front. Biosci. 9, 283–289.

Drexler, S.M., Merz, C.J., Hamacher-Dang, T.C., Tegenthoff, M., Wolf, O.T., 2015. Effects of cortisol on reconsolidation of reactivated fear memories. Neuropsychopharmacology 40, 3036–3043.

Ebrecht, M., Hextall, J., Kirtley, L.-G., Taylor, A., Dyson, M., Weinman, J., 2004. Perceived stress and cortisol levels predict speed of wound healing in healthy male adults. Psychoneuroendocrinology 29, 798–809.

Eccleston, C., Crombez, G., Scotford, A., Clinch, J., Connell, H., 2004. Adolescent chronic pain: patterns and predictors of emotional distress in adolescents with chronic pain and their parents. Pain 108, 221–229.

Edvardsson, D., Varrailhon, P., Edvardsson, K., 2013. Promoting person-centeredness in long-term care: An exploratory study. J. Gerontol. Nurs. 40, 46–53.

El Aidy, S., Dinan, T.G., Cryan, J.F., 2014. Immune modulation of the brain-gut-microbe axis. Front. Microbiol. 5, 146. doi:10.3389/fmicb.2014.00146.

Elsenbruch, S., 2011. Abdominal pain in irritable bowel syndrome: a review of putative psychological, neural and neuro-immune mechanisms. Brain Behav. Immun. 25, 386–394.

Emery, C.F., Kiecolt-Glaser, J.K., Glaser, R., Malarkey, W.B., Frid, D.J., 2005. Exercise accelerates wound healing among healthy older adults: a preliminary investigation. J. Gerontol. A. Biol Sci. Med. Sci. 60, 1432–1436.

Fagundes, C.P., Glaser, R., Kiecolt-Glaser, J.K., 2013. Stressful early life experiences and immune dysregulation across the lifespan. Brain Behav. Immun. 27, 8–12.

Feil, R., 2006. Environmental and nutritional effects on the epigenetic regulation of genes. Mutat. Res. 600, 46–57.

Feil, R., Fraga, M.F., 2012. Epigenetics and the environment: emerging patterns and implications. Nat. Rev. Genet. 13, 97–109.

Finniss, D.G., Kaptchuk, T.J., Miller, F., Benedetti, F., 2010. Biological, clinical, and ethical advances of placebo effects. Lancet 375, 686–695.

Fleischman, D.S., Bunevicius, A., Leserman, J., Girdler, S.S., 2014. Menstrually related mood disorders and a history of abuse: moderators of pain sensitivity. Health Psychol. 33, 147.

Gallegos, A.M., Lytle, M.C., Moynihan, J.A., Talbot, N.L., 2015. Mindfulness-based stress reduction to enhance psychological functioning and improve inflammatory biomarkers in trauma-exposed women: A pilot study. Psychol. Trauma 7, 525.

Ganzel, B.L., Morris, P.A., Wethington, E., 2010. Allostasis and the human brain: Integrating models of stress from the social and life sciences. Psychol. Rev. 117, 134.

Garland, E.L., Howard, M.O., 2009. Neuroplasticity, psychosocial genomics, and the biopsychosocial paradigm in the 21st century. Health Soc. Work 34, 191–199.

Generaal, E., Vogelzangs, N., Macfarlane, G.J., Geenen, R., Smit, J.H., De Geus, E.J., et al., 2015. Biological stress systems, adverse life events and the onset of chronic multisite musculoskeletal pain: a 6-year cohort study. Ann. Rheum. Dis. 75, 847–854.

Gianferante, D., Thoma, M.V., Hanlin, L., Chen, X., Breines, J.G., Zoccola, P.M., et al., 2014. Post-stress rumination predicts HPA axis responses to repeated acute stress. Psychoneuroendocrinology 49, 244–252.

Gifford, L., 1998. Pain, the tissues and the nervous system: A conceptual model. Physiotherapy 84, 27–36.

Gifford, L., 2014. Aches and Pains. Aches and Pains Ltd, Falmouth.

Gillick, B.T., Zirpel, L., 2012. Neuroplasticity: an appreciation from synapse to system. Arch. Phys. Med. Rehabil. 93, 1846–1855.

Girish, G., Lobo, L.G., Jacobson, J.A., Morag, Y., Miller, B., Jamadar, D.A., 2011. Ultrasound of the shoulder: asymptomatic findings in men. AJR Am J. Roentgenol. 197, W713–W719.

Godbout, J.P., Glaser, R., 2006. Stress-induced immune dysregulation: implications for wound healing, infectious disease and cancer. J. Neuroimmune Pharmacol. 1, 421–427.

Gold, P., 2015. The organization of the stress system and its dysregulation in depressive illness. Mol. Psychiatry 20, 32–47.

Gouin, J.-P., Kiecolt-Glaser, J.K., Malarkey, W.B., Glaser, R., 2008. The influence of anger expression on wound healing. Brain Behav. Immun. 22, 699–708.

Grace, P.M., Hutchinson, M.R., Maier, S.F., Watkins, L.R., 2014. Pathological pain and the neuroimmune interface. Nat. Rev. Immunol. 14, 217–231.

Hadjistavropoulos, T., Craig, K.D., Duck, S., Cano, A., Goubert, L., Jackson, P.L., et al., 2011. A biopsychosocial formulation of pain communication. Psychol. Bull. 137, 910.

Harte, J.L., Eifert, G.H., Smith, R., 1995. The effects of running and meditation on beta-endorphin, corticotropin-releasing hormone and cortisol in plasma, and on mood. Biol. Psychol. 40, 251–265.

Heim, C., Ehlert, U., Hellhammer, D.H., 2000. The potential role of hypocortisolism in the pathophysiology of stress-related bodily disorders. Psychoneuroendocrinology 25, 1–35.

Hillier, S., Worley, A., 2015. The effectiveness of the feldenkrais method: a systematic review of the evidence. Evid. Based Complement. Alternat. Med. doi:10.1155/2015/752160.

Hirsh, A.T., George, S.Z., Bialosky, J.E., Robinson, M.E., 2008. Fear of pain, pain catastrophizing, and acute pain perception: relative prediction and timing of assessment. J. Pain 9, 806–812.

Ho-Joong Kim, M., Bo-Gun Suh, M., Dong-Bong Lee, M., Gun-Woo Lee, M., Dong-Whan Kim, M., Kyoung-Tak Kang, M., et al., 2013. The influence of pain sensitivity on the symptom severity in patients with lumbar spinal stenosis. Pain Physician 16, 135–144.

Hoeger Bement, M., Weyer, A., Keller, M., Harkins, A.L., Hunter, S.K., 2010. Anxiety and stress can predict pain perception following a cognitive stress. Physiol. Behav. 101, 87–92.

Hoffmann, T., Tooth, L., 2009. Talking with clients about evidence. In: Hoffmann, T., Bennett, S., Del Mar, C. (Eds.), Evidence-based Practice Across the Health Professions. Elsevier Australia, Sydney.

Husarik, D.B., Saupe, N., Pfirrmann, C.W., Jost, B., Hodler, J., Zanetti, M., 2010. Ligaments and plicae of the elbow: normal MR imaging variability in 60 asymptomatic subjects 1. Radiology 257, 185–194.

Jänig, W., Chapman, C., Green, P., 2006. Pain and body protection: sensory, autonomic, neuroendocrine, and behavioral mechanisms in the control of inflammation and hyperalgesia. In: Proceedings of the 11th World Congress on Pain. IASP Press, Seattle, pp. 331–347.

Jarvik, J.G., Gold, L.S., Comstock, B.A., Heagerty, P.J., Rundell, S.D., Turner, J.A., et al., 2015. Association of early imaging for back pain with clinical outcomes in older adults. JAMA 313, 1143–1153.

Jensen, M.C., Brant-Zawadzki, M.N., Obuchowski, N., Modic, M.T., Malkasian, D., Ross, J.S., 1994. Magnetic resonance imaging of the lumbar spine in people without back pain. NEJM 331, 69–73.

Jensen, M.P., Adachi, T., Tomes-Peres, C., Lee, J., et al., 2015. Mechanisms of hypnosis: toward the development of a biopsychosocial model. Int. J. Clin. Exp. Hypn. 63, 34–75.

Johansen, O., Brox, J., Flaten, M.A., 2003. Placebo and nocebo responses, cortisol, and circulating beta-endorphin. Psychosom. Med. 65, 786–790.

Johnstone, D.M., Mitrofanis, J., Stone, J., 2015. Targeting the body to protect the brain: inducing neuroprotection with remotely-applied near infrared light. Neural Regen. Res. 10, 349.

Johnstone, L., Dallos, R. (Eds.), 2013. Formulation in Psychology and Psychotherapy: Making Sense of People's Problems. Routledge, London.

Jones, L., 2007. Introduction to current concepts of pain. In: Partridge, C. (Ed.), Recent Advances of Physiotherapy. Wiley, London.

Jones, L.E., O'Shaughnessy, D.F., 2014. The pain and movement reasoning model: introduction to a simple tool for integrated pain assessment. Man. Ther. 19, 270–276.

Juster, R.-P., McEwen, B.S., 2015. Sleep and chronic stress: new directions for allostatic load research. Sleep Med. 16, 7–8.

Juster, R.-P., Sindi, S., Marin, M.-F., Perna, A., Hashemi, A., Pruessner, J.C., et al., 2011. A clinical allostatic load index is associated with burnout symptoms and hypocortisolemic profiles in healthy workers. Psychoneuroendocrinology 36, 797–805.

Kabat-Zinn, J., 2003. Mindfulness-based interventions in context: past, present, and future. Clin. Psychol. Sci. Pract. 10, 144–156.

Kaltsas, G.A., Chrousos, G.P., 2007. The neuroendocrinology of stress. In: Cacioppo, J., Tassinary, L., Bernston, G. (Eds.), Handbook of Psychophysiology. Cambridge University Press.

Kaplan, B.J., Rucklidge, J.J., Romijn, A., Mcleod, K., 2015. The emerging field of nutritional mental health inflammation, the microbiome, oxidative stress, and mitochondrial function. Clin. Psychol. Sci. 3, 964–980.

Katz, J., Weinrib, A., Fashler, S.R., Katznelzon, R., Shah, B.R., Ladak, S.S., et al., 2015. The Toronto General Hospital transitional pain service: development and implementation of a multidisciplinary program to prevent chronic postsurgical pain. J. Pain Res. 8, 695–702.

Keefe, F.J., Shelby, R.A., Somers, T.J., 2010. Catastrophizing and pain coping: moving forward. Pain 149, 165–166.

Kent, S., Bluthé, R.-M., Kelley, K.W., Dantzer, R., 1992. Sickness behavior as a new target for drug development. Trends Pharmacol. Sci. 13, 24–28.

Khalil, H., Cullen, M., Chambers, H., Carroll, M., Walker, J., 2015. Elements affecting wound healing time: an evidence based analysis. Wound Repair Regen. 23, 550–556.

Khan, R.S., Ahmed, K., Blakeway, E., Skapinakis, P., Nihoyannopoulos, L., Macleod, K., et al., 2011. Catastrophizing:

a predictive factor for postoperative pain. Am. J. Surg. 201, 122–131.

Kidd, M.O., Bond, C.H., Bell, M.L., 2011. Patients' perspectives of patient-centredness as important in musculoskeletal physiotherapy interactions: a qualitative study. Physiotherapy 97, 154–162.

Kiecolt-Glaser, J.K., Christian, L., Preston, H., Houts, C.R., Malarkey, W.B., Emery, C.F., et al., 2010. Stress, inflammation, and yoga practice. Psychosom. Med. 72, 113.

Kiecolt-Glaser, J.K., Loving, T.J., Stowell, J.R., Malarkey, W.B., Lemeshow, S., Dickinson, S.L., et al., 2005. Hostile marital interactions, proinflammatory cytokine production, and wound healing. Arch. Gen. Psychiatry 62, 1377–1384.

Kleim, J.A., 2011. Neural plasticity and neurorehabilitation: teaching the new brain old tricks. J. Commun. Disord. 44, 521–528.

Klengel, T., Binder, E.B., 2015. Epigenetics of stress-related psychiatric disorders and gene× environment interactions. Neuron 86, 1343–1357.

Koschwanez, H.E., Kerse, N., Darragh, M., Jarrett, P., Booth, R.J., Broadbent, E., 2013. Expressive writing and wound healing in older adults: a randomized controlled trial. Psychosom. Med. 75, 581–590.

Kudielka, B.M., Wüst, S., 2010. Human models in acute and chronic stress: assessing determinants of individual hypothalamus–pituitary–adrenal axis activity and reactivity. Stress 13, 1–14.

LeDoux, J.E., 2012. Evolution of human emotion: a view through fear. Prog. Brain Res. 195, 431.

Lengacher, C.A., Kip, K.E., Barta, M., Post-White, J., Jacobsen, P.B., Groer, M., et al., 2012. A pilot study evaluating the effect of mindfulness-based stress reduction on psychological status, physical status, salivary cortisol, and interleukin-6 among advanced-stage cancer patients and their caregivers. J. Holist. Nurs. 30, 170–185.

Levine, M., Cole, S., Weir, D., Crimmins, E., 2015. Childhood and later life stressors and increased inflammatory gene expression at older ages. Soc. Sci. Med. 130, 16–22.

Levite, M., 2015. Dopamine and T Cells: Receptors, direct and potent effects, endogenous production and abnormalities in autoimmune, neurological and psychiatric diseases. Acta Physiol. 216, 42–89.

Liezmann, C., Stock, D., Peters, E.M., 2012. Stress induced neuroendocrine-immune plasticity: A role for the spleen in peripheral inflammatory disease and inflammaging? Dermatoendocrinol. 4, 271–279.

Lirk, P., Fiegl, H., Weber, N., Hollmann, M., 2015. Epigenetics in the perioperative period. Br. J. Pharmacol. 172, 2748–2755.

Logan, A.C., 2015. Dysbiotic drift: mental health, environmental grey space, and microbiota. Dementia 8, 9.

Maier, S.F., Watkins, L.R., 1998. Cytokines for psychologists: implications of bidirectional immune-to-brain communication for understanding behavior, mood, and cognition. Psychol. Rev. 105, 83.

Mao, G.-X., Lang, X.G., Cao, Y.B., He, Z.H., Lu, Y.D., et al., 2012. Therapeutic effect of forest bathing on human hypertension in the elderly. J. Cardiol. 60, 495–502.

Marucha, P.T., Kiecolt-Glaser, J.K., Favagehi, M., 1998. Mucosal wound healing is impaired by examination stress. Psychosom. Med. 60, 362–365.

Mauss, D., Jian, L., Schmidt, B., Angerer, P., Jarczok, M.N., 2015. Measuring allostatic load in the workforce: a systematic review. Ind. Health 53, 5.

McEwen, B.S., 2001. Plasticity of the hippocampus: adaptation to chronic stress and allostatic load. Ann. N. Y. Acad. Sci. 933, 265–277.

McEwen, B.S., 2007. Physiology and neurobiology of stress and adaptation: central role of the brain. Physiol. Rev. 87, 873–904.

McEwen, B.S., 2012. Brain on stress: how the social environment gets under the skin. Proc. Natl. Acad. Sci. U. S. A. 109, 17180–17185.

McEwen, B.S., 2015. Preserving neuroplasticity: role of glucocorticoids and neurotrophins via phosphorylation. Proc. Natl. Acad. Sci. U. S. A. 112, 15544–15545.

McEwen, B.S., Gray, J.D., Nasca, C., 2015. Recognizing resilience: learning from the effects of stress on the brain. Neurobiol. Stress 1, 1–11.

McEwen, B.S., Karatsoreos, I.N., 2015. Sleep deprivation and circadian disruption: stress, allostasis, and allostatic load. Sleep Med. Clin. 10, 1–10.

McEwen, B.S., Nasca, C., Gray, J.D., 2016. Stress effects on neuronal structure: hippocampus, amygdala, and prefrontal cortex. Neuropsychopharmacology 41, 3–23.

McEwen, B.S., Wingfield, J.C., 2003. The concept of allostasis in biology and biomedicine. Horm. Behav. 43, 2–15.

Mcinnis, C.M., Wang, D., Gianferante, D., Hanlin, L., Chen, X., Thoma, M.V., et al., 2015. Response and habituation of pro-and anti-inflammatory gene expression to repeated acute stress. Brain Behav. Immun. 46, 237–248.

McMahon, S.B., Cafferty, W.B., Marchand, F., 2005. Immune and glial cell factors as pain mediators and modulators. Exp. Neurol. 192, 444–462.

Melzack, R., 2001. Pain and the neuromatrix in the brain. J. Dent. Educ. 65, 1378–1382.

Melzack, R., 2005. Evolution of the Neuromatrix Theory of Pain. The Prithvi Raj Lecture: Presented at the Third World Congress of World Institute of Pain, Barcelona 2004. Pain Pract. 5, 85–94.

Milligan, E.D., Watkins, L.R., 2009. Pathological and protective roles of glia in chronic pain. Nat. Rev. Neurosci. 10, 23–36.

Moffett, J.A.K., Richardson, P.H., 1995. The influence of psychological variables on the development and perception of musculoskeletal pain. Physiother. Theory Pract. 11, 3–11.

Moloney, R.D., Desbonnet, L., Clarke, G., Dinan, T.G., Cryan, J.F., 2014. The microbiome: stress, health and disease. Mamm. Genome 25, 49–74.

Moseley, G., Butler, D., 2015. The Explain Pain Handbook: Protectometer. Noigroup Publications, Adelaide.

Moseley, G.L., 2007. Reconceptualising pain according to its underlying biology. Phys. Ther. Rev. 12, 169–178.

Muscatell, K.A., et al., 2015. Greater amygdala activity and dorsomedial prefrontal–amygdala coupling are associated with enhanced inflammatory responses to stress. Brain Behav. Immun. 43, 46–53.

Nakashima, H., Yukawa, Y., Suda, K., Yamagata, M., Ueta, T., Kato, F., 2015. Abnormal findings on magnetic resonance images of the cervical spines in 1211 asymptomatic subjects. Spine 40, 392–398.

Nardo, L., Parimi, N., Liu, F., Lee, S., Jungmann, P.M., Nevitt, M.C., et al., 2015. Femoroacetabular impingement: prevalent and often asymptomatic in older men: the osteoporotic fractures in men study. Clin. Orthop. Relat. Res. 1–9.

Nicolaides, N.C., Kyratzi, E., Lamprokostopoulou, A., Chrousos, G.P., Charmandari, E., 2015. Stress, the stress system and the role of glucocorticoids. Neuroimmunomodulation 22, 6–19.

Offidani, E., Ruini, C., 2012. Psychobiological correlates of allostatic overload in a healthy population. Brain Behav. Immun. 26, 284–291.

Öhman, A., 2005. The role of the amygdala in human fear: automatic detection of threat. Psychoneuroendocrinology 30, 953–958.

Padgett, D.A., Glaser, R., 2003. How stress influences the immune response. Trends Immunol. 24, 444–448.

Parsons, S., Harding, G., Breen, A., Foster, N., Pincus, T., Vogel, S., et al., 2007. The influence of patients' and primary care practitioners' beliefs and expectations about chronic musculoskeletal pain on the process of care: a systematic review of qualitative studies. Clin. J. Pain 23, 91–98.

Pedersen, L.M., Schistad, E., Jacobsen, L.M., Røe, C., Gjerstad, J., 2015. Serum levels of the pro-inflammatory interleukins 6 (IL-6) and-8 (IL-8) in patients with lumbar radicular pain due to disc herniation: a 12-month prospective study. Brain Behav. Immun. 46, 132–136.

Phillips, K., Wright, B.J., Kent, S., 2014. Irritable bowel syndrome and symptom severity: Evidence of negative attention bias, diminished vigour, and autonomic dysregulation. J. Psychosom. Res. 77, 13–19.

Pinto, R.Z., Ferreira, M.L., Oliveira, V.C., Franco, M.R., Adams, R., Maher, C.G., et al., 2012. Patient-centred communication is associated with positive therapeutic alliance: a systematic review. J. Physiother. 58, 77–87.

Pittenger, C., Duman, R.S., 2008. Stress, depression, and neuroplasticity: a convergence of mechanisms. Neuropsychopharmacology 33, 88–109.

Ploghaus, A., Narain, C., Beckmann, C.F., Clare, S., Bantick, S., Wise, R., et al., 2001. Exacerbation of pain by anxiety is associated with activity in a hippocampal network. J. Neurosci. 21, 9896–9903.

Poljšak, B., Milisav, I., 2012. Clinical implications of cellular stress responses. Bosn. J. Basic Med. Sci. 12, 122–126.

Pomeroy, V., Tallis, R., 2002. Restoring movement and functional ability after stroke: now and the future. Physiotherapy 88, 3–17.

Quartana, P.J., Buenaver, L.F., Edwards, R.R., Klick, B., Haythornthwaite, J.A., Smith, M.T., 2010. Pain catastrophizing and salivary cortisol responses to laboratory pain testing in temporomandibular disorder and healthy participants. J. Pain 11, 186–194.

Radley, J.J., Kabbaj, M., Jacobson, L., Heydendael, W., Yehuda, R., Herman, J.P., 2011. Stress risk factors and stress-related pathology: neuroplasticity, epigenetics and endophenotypes. Stress 14, 481–497.

Rash, J.A., Aguirre-Camacho, A., Campbell, T.S., 2014. Oxytocin and pain: a systematic review and synthesis of findings. Clin. J. Pain 30, 453–462.

Reiner, K., Tibi, L., Lipsitz, J.D., 2013. Do Mindfulness-Based Interventions Reduce Pain Intensity? A Critical Review of the Literature. Pain Med. 14, 230–242.

Rhodes, A., Spinazzola, J., Van Der Kolk, B., 2016. Yoga for adult women with chronic PTSD: A long-term follow-up study. J. Altern. Complement. Med. 22, 189–196.

Riley, K.E., Park, C.L., 2015. How does yoga reduce stress? A systematic review of mechanisms of change and guide to future inquiry. Health Psychol. Rev. 9, 379–396.

Robert-McComb, J.J., Chyu, M.-C., Tacon, A., Norman, R., 2015. The effects of tai chi on measures of stress and coping style. Focus Altern. Complement. Ther. 20, 89–96.

Rosas-Ballina, M., Tracey, K.J., 2009. The neurology of the immune system: neural reflexes regulate immunity. Neuron 64, 28–32.

Samuels, E., Szabadi, E., 2008. Functional neuroanatomy of the noradrenergic locus coeruleus: its roles in the regulation of arousal and autonomic function part I: principles of functional organisation. Curr. Neuropharmacol. 6, 235.

Sarkar, C., Basu, B., Chakroborty, D., Dasgupta, P.S., Basu, S., 2010. The immunoregulatory role of dopamine: an update. Brain Behav. Immun. 24, 525–528.

Schaible, H.-G., Ebersberger, A., Natura, G., 2011. Update on peripheral mechanisms of pain: beyond prostaglandins and cytokines. Arthritis Res. Ther. 13, 210.

Schalinski, I., Elbert, T., Steudte-Schmiedgen, S., Kirschbaum, C., 2015. The cortisol paradox of trauma-related disorders: lower phasic responses but higher tonic levels of cortisol are associated with sexual abuse in childhood. PLoS ONE 10, e0136921 doi:10.1371/journal.pone.0136921.

Schulz, A., Vögele, C., 2015. Interoception and stress. Front. Psychol. 6, 993.

Sharma, M., Knowlden, A.P., 2012. Role of yoga in preventing and controlling type 2 diabetes mellitus. J. Evid. Based Complement. Altern. Med. 17, 88–95.

Sher, J.S., Uribe, J.W., Posada, A., Murphy, B.J., Zlatkin, M.B., 1995. Abnormal findings on magnetic resonance images of asymptomatic shoulders. J. Bone Joint Surg. Am. 77, 10–15.

Snodgrass, S.J., Heneghan, N.R., Tsao, H., Stanwell, P.T., Rivett, D.A., Van Vliet, P.M., 2014. Recognising neuroplasticity in musculoskeletal rehabilitation: a basis for greater collaboration between musculoskeletal and neurological physiotherapists. Man. Ther. 19, 614–617.

Sommer, C., Kress, M., 2004. Recent findings on how proinflammatory cytokines cause pain: peripheral mechanisms in inflammatory and neuropathic hyperalgesia. Neurosci. Lett. 361, 184–187.

Sprouse-Blum, A.S., Smith, G., Sugai, D., Parsa, F.D., 2010. Understanding endorphins and their importance in pain management. Hawaii Med. J. 69, 70.

Stehling, C., Lane, N., Nevitt, M., Lynch, J., Mcculloch, C., Link, T., 2010. Subjects with higher physical activity levels have more severe focal knee lesions diagnosed with 3T MRI: analysis of a non-symptomatic cohort of the osteoarthritis initiative. Osteoarthritis Cartilage 18, 776–786.

Stephens, R., Atkins, J., Kingston, A., 2009. Swearing as a response to pain. Neuroreport 20, 1056–1060.

Stephens, R., Umland, C., 2011. Swearing as a response to pain—effect of daily swearing frequency. J. Pain 12, 1274–1281.

Stipursky, J., Romão, L., Tortelli, V., Neto, V.M., Gomes, F.C.A., 2011. Neuron–glia signaling: Implications for astrocyte differentiation and synapse formation. Life Sci. 89, 524–531.

Stone, J., 2016. The heart, dementia and why stress can be good for you. In: Ockham's Razor. 2016: Australian Broadcasting Commission.

Stone, L.S., Szyf, M., 2013. The emerging field of pain epigenetics. Pain 154, 1–2.

Straube, S., Heesen, M., 2015. Pain and sleep. Pain 156, 1371–1372.

Sun, J., Chang, E.B., 2014. Exploring gut microbes in human health and disease: pushing the envelope. Genes Dis. 1, 132–139.

Tekur, P., Nagarathna, R., Chametcha, S., Hankey, A., Nagendra, H., 2012. A comprehensive yoga programs improves pain, anxiety and depression in chronic low back pain patients more than exercise: an RCT. Complement. Ther. Med. 20, 107–118.

Thacker, M.A., Clark, A.K., Marchand, F., McMahon, S.B., 2007. Pathophysiology of peripheral neuropathic pain: immune cells and molecules. Anesth. Analg. 105, 838–847.

Trojan, S., Pokorny, J., 1999. Theoretical aspects of neuroplasticity. Physiol. Res. 48, 87–98.

Turner, J.A., Holtzman, S., Mancl, L., 2007. Mediators, moderators, and predictors of therapeutic change in cognitive–behavioral therapy for chronic pain. Pain 127, 276–286.

Uematsu, S., Akira, S., 2007. Toll-like receptors and Type I interferons. J. Biol. Chem. 282, 15319–15323.

Underwood, C., 2011. Getting students moving. Res. Dev. 24, 3.

Ursin, H., 1994. Stress, distress, and immunity. Ann. N. Y. Acad. Sci. 741, 204–211.

Vancampfort, D., De Hert, M., Knapen, J., Wampers, M., Demunter, H., Deckx, S., et al., 2011. State anxiety, psychological stress and positive well-being responses to yoga and aerobic exercise in people with schizophrenia: a pilot study. Disabil. Rehabil. 33, 684–689.

Vervoort, T., Goubert, L., Eccleston, C., Bijttebier, P., Crombez, G., 2006. Catastrophic thinking about pain is independently associated with pain severity, disability, and somatic complaints in school children and children with chronic pain. J. Pediatr. Psychol. 31, 674–683.

Ward, L., Stebbings, S., Cherkin, D., Baxter, G.D., 2013. Yoga for functional ability, pain and psychosocial outcomes in musculoskeletal conditions: a systematic review and meta-analysis. Musculoskeletal Care 11, 203–217.

Watkins, L., Maier, S., 2000. The pain of being sick: implications of immune-to-brain communication for understanding pain. Annu. Rev. Psychol. 51, 29–57.

Watkins, L., Maier, S., 2005. Immune regulation of central nervous system functions: from sickness responses to pathological pain. J. Intern. Med. 257, 139–155.

Watkins, L.R., Hutchinson, M.R., Milligan, E.D., Maier, S.F., 2007. "Listening" and "talking" to neurons: Implications of immune activation for pain control and increasing the efficacy of opioids. Brain Res. Rev. 56, 148–169.

Watkins, L.R., Maier, S.F., 2002. Beyond neurons: evidence that immune and glial cells contribute to pathological pain states. Physiol. Rev. 82, 981–1011.

Watkins, L.R., Maier, S.F., Goehler, L.E., 1995. Immune activation: the role of pro-inflammatory cytokines in

inflammation, illness responses and pathological pain states. Pain 63, 289–302.

Webster, B.S., Cifuentes, M., 2010. Relationship of early magnetic resonance imaging for work-related acute low back pain with disability and medical utilization outcomes. J. Occup. Environ. Med. 52, 900–907.

Webster Marketon, J.I., Glaser, R., 2008. Stress hormones and immune function. Cell. Immunol. 252, 16–26.

Woolf, C.J., 2011. Central sensitization: Implications for the diagnosis and treatment of pain. Pain 152, S2–S15.

Wrona, D., 2006. Neural–immune interactions: an integrative view of the bidirectional relationship between the brain and immune systems. J. Neuroimmunol. 172, 38–58.

Wüst, S., Federenko, I.S., Rossum, E.F., Koper, J.W., Kumsta, R., Entringer, S., et al., 2004. A psychobiological perspective on genetic determinants of hypothalamus-pituitary-adrenal axis activity. Ann. N. Y. Acad. Sci. 1032, 52–62.

Wüst, S., Federenko, I.S., Van Rossum, E.F., Koper, J.W., Hellhammer, D.H., 2005. Habituation of cortisol responses to repeated psychosocial stress—further characterization and impact of genetic factors. Psychoneuroendocrinology 30, 199–211.

Yan, Y., Jiang, W., Liu, L., Wang, X., Ding, C., Tian, Z., et al., 2015. Dopamine controls systemic inflammation through inhibition of NLRP3 inflammasome. Cell 160, 62–73.

Zannas, A.S., West, A.E., 2014. Epigenetics and the regulation of stress vulnerability and resilience. Neuroscience 264, 157–170.

Zilioli, S., Slatcher, R.B., Ong, A.D., Gruenewald, T.L., 2015. Purpose in life predicts allostatic load ten years later. J. Psychosom. Res. 79, 451–457.

Zoccola, P.M., Dickerson, S.S., 2012. Assessing the relationship between rumination and cortisol: A review. J. Psychosom. Res. 73, 1–9.

Zoccola, P.M., Quas, J.A., Yim, I.S., 2010. Salivary cortisol responses to a psychosocial laboratory stressor and later verbal recall of the stressor: The role of trait and state rumination. Stress 13, 435–443.

Zusman, M., 2008. Associative memory for movement-evoked chronic back pain and its extinction with musculoskeletal physiotherapy. Phys. Ther. Rev. 13, 57–68.

Zusman, M., 2012. A review of the proposal that innocuous proprioceptive input may maintain movement-evoked joint pain. Phys. Ther. Rev. 17, 346–349.

Zusman, M., 2013. Belief reinforcement: one reason why costs for low back pain have not decreased. J. Multidiscip. Healthc. 6, 197.

## 2.4 Related publications

This published work has informed my contributions to two subsequent journal articles and a book chapter. The first article provided an overview of multimodal strategies for General Practitioners to use with people with pain (Holliday et al., 2018). We promoted a concept of pain that included the modulation of the nervous system and the immune and endocrine influences on pain. When conceptualising pain this way, pain management needs to move from a *narrow sensory focus* to incorporate education, psychological treatment and exercise. The second paper was a multidisciplinary perspective on pain in refugees (Lies, Jones, & Ho, 2019). Similarly, we presented the idea of pain as a *psychophysiological alarm* that is part of a *sophisticated body protection system*. Therefore, emphasising the need to consider non-pathoanatomic influences on pain including adverse life events. The book chapter, co-authored with Des O'Shaughnessy (2020), explores pain in the sporting context including commentary on the modulation of the nervous system and the effect of stressors. Again, we argue that a simple pathoanatomic approach is inadequate for the effective management of pain and a more comprehensive approach is required.

## 2.5 Concluding comments

The published work presented in this chapter explored the current knowledge on stress, pain and recovery. This enhances the theory underpinning the Pain and Movement Reasoning Model with further evidence supporting the multidimensions of pain and the importance of considering mediating and moderating factors influencing a person's pain. It is apparent that physiotherapists should attend to both pain-related and non-pain related stressors during clinical reasoning and formulation processes. This

should lead to a more effective understanding of a person's pain, a broader selection of treatment modalities and more effective person-centred management.

## 2.6 References


Holliday, S., Hayes, C., **Jones, L. E.**, Gordon, J., Harris, N., & Nicholas, M. (2018). Prescribing wellness: Comprehensive pain management outside specialist services. *Australian Prescriber, 41*(3), 86-91.

**Jones, L. E.** (2017). Stress, pain and recovery: Neuro-immune-endocrine interactions and clinical practice. In S. B. Porter (Ed.), *Psychologically Informed Physiotherapy: Embedding Psychosocial Perspectives Within Clinical Management*, pp. 78-106. Edinburgh, UK: Elsevier.

Lies, J., **Jones, L. E.**, & Ho, R. (2019). The management of post-traumatic stress disorder and associated pain and sleep disturbance in refugees. *BJPsych Advances, 25*(3), 196-206. doi:10.1192/bja.2019.7

O'Shaughnessy, D. F. P., & **Jones, L. E.** (2020). Making sense of pain in sports physiotherapy: Applying the Pain and Movement Reasoning Model. In S. B. Porter & J. Wilson (Eds.), *A Comprehensive Guide to Sports Physiology and Injury Management,* Elsevier.

# Chapter 3 – Meaning of pain and the social context

Chapter 3 focuses on the cognitive-evaluative dimension of pain perception. In this chapter I introduce the published work, initially with some background on how I was drawn to the study of labour pain and then by providing the context for the book chapter.

## 3.1 Introduction to published work

### 3.1.1 Developing an interest in the study of labour pain

While attending the International Association for the Study of Pain World Congress in Glasgow in 2008, I was impressed by a poster on catastrophising and pain associated with childbirth; subsequently published in *European Journal of Pain* (Flink, Mroczek, Sullivan, & Linton, 2009). Having watched my wife birth my two daughters so beautifully and realising how variable women's experiences can be, I promised myself to take this new work to the Judith Lumley Centre (then the Mother and Child Health Research Centre) at La Trobe University, thinking they might find it valuable to integrate into their work. I met with Professor Rhonda Small and Dr Mary-Ann Davey. Rather than the one-off meeting I was expecting, we realised the way I was thinking about pain from a neuroscience perspective aligned with midwifery and woman-centered approaches to pain and that there was scope for us to explore this further. This led to the six-month research residency (introduced in Section 1.5) at the Centre and an initial research project investigating women's expectations and experiences of threat, safety and pain. Laura Whitburn was employed as a research assistant; following this she pursued *The Nature of Labour Pain* as her PhD topic.

### 3.1.2 The uniqueness of labour pain

The pain associated with childbirth presents a unique context to examine *cognitive-related and emotion-related* inputs (Melzack, 2005) and how they might influence pain perception. This is because normal uncomplicated labour can be considered a physiological process and so pain can be examined without the complication of tissue disease or pathology. There is still likely to be a nociceptive contribution to pain, but contextually the difference between pain associated with a pathologic condition and pain associated with an event for which a positive outcome is expected, is valuable to explore.

In the birthing context, it is apparent that the perception of pain and how women cope with pain, can vary from moment to moment. That is, pain is dynamic. To use the language of Gifford (1998), the brain is constantly *scrutinising* and *sampling* cues from the internal and external environment. Applying this to labour pain, a woman's pain is affected both by what is happening within her body and by what is happening around her.

## 3.2 The book

The first volume of *Meanings of Pain* was published in 2016 and brought together a collection of 23 chapters focusing on the study of meanings of pain (van Rysewyk, 2016). In the second volume (van Rysewyk, 2019), the collection focused on common types of pain, and on the importance of language, and Laura Whitburn was invited to lead a contribution on Labour Pain. Our chapter was one of 16, the others included chapters written by people with pain, and chapters addressing the understanding, the suffering and the expression of pain.

## 3.3 Contributions

| CRediT author statement | |
|---|---|
| Laura Y. Whitburn (50%) | • Conceptualisation<br>• Literature review<br>• Writing – original draft<br>• Writing – review and editing |
| Lester E. Jones (50%) | • Conceptualisation<br>• Literature review<br>• Writing – original draft<br>• Writing – review and editing |
| Rhonda Small<br>(*Primary Supervisor 2014-2016*) | • Writing – review and editing<br>*(below threshold for authorship)* |

## 3.4 Published work

Whitburn, L. Y., & **Jones, L. E.** (2019). Labour pain. In S. van Rysewyk (Ed.), Meanings of Pain (Vol. 2), pp. 143-162. Springer. https://doi.org/10.1007/978-3-030-24154-4

*Permission statement*

Reprinted with permission from Springer Nature Customer Service Centre GmbH: Springer, Chapter 8 Labour pain by Laura Whitburn and Lester Jones. In Simon van Rysewyk (Ed.), Meanings of Pain (Vol. 2), 2019.

# Chapter 8
# Labour Pain

**Laura Whitburn and Lester Jones**

*Where it is unavoidable, pain can be transformed into something useable, something which wakes us beyond the limits of the experience itself into a further grasp of the essentials of life and the possibilities within us. . .This insight illuminates much of the female condition, but in particular the experience of giving birth [1, p. 158].*

**Abstract** Contemporary thinking about pain suggests its ultimate function is more than just to indicate bodily injury, pathology or disease. This would seem especially important in the pain that a woman feels during labour and childbirth. The event of birthing a child is essentially a normal and vital physiological process but the pain women report can be extreme. In addition, it can be quite variable, and the variability cannot be explained by tissue-based factors alone. The variability extends not just to the intensity of the pain but also to its quality and behaviour. Equally variable is the ability for women to cope with the pain associated with childbirth. It can be anticipated that individuals will have differing capacities to cope, but the variability can also be a moment-to-moment proposition for the individual woman. In this chapter we will discuss the idea that the meaning of labour pain to the woman may be more important than its nature or intensity in determining the balance between coping and acopia and in defining her overall experience. In doing so, we will also highlight the limitations in current conceptions of pain that cannot yet fully account for unique occurrences of pain, such as the pain of labour and childbirth.

*Capsule Summary:* The concepts explored in this chapter emphasise the need to attend to the individual meaning that a woman ascribes to her pain experience during labour. We suggest that by conceptualising labour pain as a productive and

L. Whitburn (✉)
La Trobe University, Melbourne, Australia
e-mail: L.Whitburn@latrobe.edu.au

L. Jones
La Trobe University, Melbourne, Australia

Singapore Institute of Technology, Singapore, Singapore

© Springer Nature Switzerland AG 2019

S. van Rysewyk (ed.), *Meanings of Pain*,
https://doi.org/10.1007/978-3-030-24154-4_8

purposeful pain, prioritising individualised social support and attending to cognitive and emotional variables that shape a woman's perception of pain, women may be more likely to have positive experiences of labour pain and less need for pharmacological intervention.

**Keywords** Labour · Pain · Childbirth · Social support · Pain cognitions · Pain control · Maternity care

## 1 Introduction

The pain associated with labour is a unique and complex phenomenon. Whilst typical experiences of pain tend to be associated with injury or disease, labour pain emerges during a vital and highly positive event. In fact, as the pain intensity rises, the labour is seen to be progressing normally! [2, 3] This pain experience raises significant philosophical and theoretical questions due to its unique occurrence. One obvious question is: Why is a normal physiological process, one that is essential to human existence, associated with such intense pain? The unique context of this pain provokes two ideas: (1) the ultimate function of pain is more than just to indicate bodily injury, pathology or disease; and (2) labour pain may be better understood if considered as different from other types of pain.

A further complexity to this pain experience is its enormous variation between women or in the same woman on different occasions, independent of the physical demands of labour on her body. Labour pain is often described as the most challenging and intense pain experience a woman can undergo. However, reports of intensity vary significantly and descriptions of this pain range from excruciating through to pleasurable [4, 5]. Some women manage the pain very well, require minimal assistance and report positive experiences, whilst others do not cope well, experience great suffering and request intervention in order to avoid or alleviate the pain [6–8]. Curiously, women have even described labour pain as a paradoxical experience—one that is both excruciating but desirable because of its positive outcome: the birth of a child [5]. This variation in both intensity and descriptions suggests that the nature of labour pain is complex, and the experience of labour pain has determinants beyond those associated with the physiological state of the woman's labouring body.

A growing argument emphasises the meaning of pain as the determining factor in defining a woman's pain experience during childbirth. Women may interpret their pain as productive and purposeful and accept it as part of their labour experience, or as a threatening pain from which they wish to escape. Thus, the meaning a woman attributes to her pain affects her relationship to the pain and her ongoing responses to it. The individual interpretation of this pain experience is a complex evaluative process influenced by personal, social, contextual and physical inputs. Furthermore, an exploration of the concept of a *productive and purposeful* pain challenges current conceptions of pain and its function. In this chapter we will examine these ideas to

better account for the individual differences in experiences reported by women, as well as to expand conceptions of pain more broadly.

## 1.1 A Brief Historical Perspective

Prior to the scientific revolution, conceptions of labour pain were mainly driven by religious and cultural beliefs. For example, the Judeo-Christian conception of labour pain was that it was Eve's punishment for her sins in the Garden of Eden: "I will make your pains in childbearing very severe; with painful labor you will give birth to children"—Genesis 3:16 [9]. Many women continue to call on their faith to give them strength during labour. In other cultures and religions, labour pain has many different meanings and functions. In traditional Japanese culture, birth is believed to be the work of the gods and overcoming labour pain is seen as an honour [10]. Chinese childbearing women report that it is shameful to scream during labour, and a proverb often used is, "If you wish to be the best person, you must suffer the bitterest of the bitter" [11]. More recent conceptions of labour pain reflect the medicalisation of birth, but many women still hold beliefs about labour pain drawn from cultural traditions.

## 1.2 Current Definition of Pain

> An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. —IASP definition of pain [12]

Definitions of pain have evolved to be more inclusive of the human pain experience. The longstanding International Association of the Study of Pain (IASP) definition of pain [12] (which should always be considered with its annotation) challenges a biomedical, exclusively tissue-based understanding of pain by emphasising the emotional component and incorporating the idea that perceived damage may be enough to explain pain.

> Pain is a distressing experience associated with actual or potential tissue damage with sensory, emotional, cognitive, and social components. —Williams and Craig's [13] proposed revised definition

Above is a recent attempt to provoke discussion for change to the IASP statement; primarily to emphasise the cognitive and social components of pain [13]. This inspired much commentary including a response from us about its capacity to (in) sufficiently account for labour pain [14] and subsequently there has been a further detailed analysis of the IASP definition [15].

In the context of labour pain, the IASP definition, including its annotation, is overly focussed on damage to tissues. The implication is that the primary function of pain is to indicate actual or potential tissue damage. Here is the dilemma: labour is a

normal physiological process and so it is hard to justify that the function of pain in that context is to indicate damage. The definition also promotes that tissue damage—whether actual or perceived—is the main contributor to the pain experience. Again, this would seem inappropriate in a process such as labour that is tissue-challenging but not necessarily tissue-injurious [16].

At this point we would like to acknowledge that women can and do sustain tissue damage during childbirth, but the pain associated with labour, we argue, is often separate to the phenomenon of tissue injury.

## *1.3 What Is the Function of Pain?*

The Australian and New Zealand College of Anaesthetists, Faculty of Pain Medicine (ANZCAFPM) promote a reorganisation of the term biopsychosocial to socio-psycho-biomedical, and this perhaps is a good starting point to capture the pain associated with labour and childbirth. However, *biomedical* may be seen to exclude the reactive, learned and pre-emptive *biology* associated with psychological and social contexts, so important in the human pain experience.

In line with the emphasis on social and psychological contexts, it has been argued that pain during labour may have more of a behavioural function, by encouraging the woman to act in a way to find a safe place to birth and to promote empathic and support behaviours in those around her [17, 18]. As labour continues, increases in pain are associated with progression [2, 16] and perhaps the ramifications of this, and maybe the function of this, is to focus the woman on the task of birthing. One benefit of the intensity of the sensation could be to disable any sophisticated cognitive processing, preventing the woman from *overthinking* and instead forcing her to *withdraw within* [19] and engage with innate and primal processes as her labour progresses.

Of course, these alternate ideas about the primary function of pain could simply be a convenient consequence of a tissue-based phenomenon, for those putting forward these more humanistic views. However, it is important to recognise that the expression of pain has evolved in a social context. It could be argued that there would not be expression of pain if it did not warn the social group of some danger and trigger a response that promoted survival of group members, or if it did not facilitate behaviour in nearby others to act in a way to protect and support the individual in pain. It is not too difficult to imagine that the perception and expression of pain are likely to have evolved together around this social function. In which case, perhaps the association of pain and tissue damage is simply a convenient consequence for those maintaining a biomedical view.

Indeed, to think of pain only as a sign of tissue damage reduces its function to one that is increasingly questionable. A large number of imaging studies on asymptomatic participants published since the 1990s would suggest structural variations occur with age and are not necessarily pathological or the source of pain [20–22]. Pain might draw us to explore tissue integrity but it is not sensitive or specific to that. It

would seem wiser to recognise pain as a driver of species preservation behaviour influenced by the complexity of psycho-socio-neuro-immune-endocrine synergies and that this may be for either protective or (re)productive purposes. This would include behaviour in response to tissue disease and damage—or perhaps more correctly put—the response to the challenge to survival (immediate or latent) that tissue disease and damage are often associated with.

If accepted fully, this argument about the development of pain perception ignores the role of pain in self-preservation behaviour that might be independent of the social context. Nevertheless, it does promote a shift in thinking that may allow a more comprehensive understanding of all types of pain and pain behaviour, but especially pain associated with labour and childbirth.

## 2 Perspectives and Theories of Labour Pain

### *2.1 Women's Report of Pain Experience*

The research into women's experiences of labour pain produces an additional concern about applying the current and proposed definitions of pain to labour and childbirth. The current definition uses the word "unpleasant" while the definition proposed more recently [13] uses "distressing." Studies report that contrary to the pain having a negative quality as these terms suggest, many women describe the pain experience in positive terms associated with empowerment, strength, happiness and even pleasure [5, 23]. Some women are even conflicted enough not to want to use the term "pain" because the pervading negative connotation does not match their birthing experience, which is overwhelmingly positive [23]. It would seem that notions of working with the pain, commonly promoted by midwifery practitioners, aligns well with embracing a positive, more physiological interpretation of pain, and taking away the pain, commonly promoted by medical practitioners, aligns more with a negative, pathological interpretation of pain. The latter obviously is also more aligned with current pain definitions.

It would also seem apparent that the approach to pain promoted by a woman's carers needs to align to her concepts of pain and her experiences can be influenced by her ability to maintain her conceptual framework during her labour. A recent review of the literature of labour pain [24] emphasised the concept of the *individual meaning* of a woman's pain experience and this may in fact be its defining feature. It has been demonstrated across numerous studies involving women from various cultural backgrounds and birthing in various models of care, that a woman's pain experience is shaped by the personal meaning that she ascribes to it. The meaning of the pain is influenced by factors including personal beliefs, the context of the pain, cognitive attributes of the woman, and the immediate social and broader socio-cultural environment in which she is birthing. Women who ultimately described their labour pain as "productive and purposeful" tended to demonstrate a greater capacity to cope. Alternatively, other women described their experience of labour

pain as a "threatening" pain, and this was often associated with a diminished capacity to cope and greater call for pain intervention.

To understand how women develop and sustain a meaning for their pain, we must first consider the broader socio-cultural and philosophical perspectives of pain. These overarching pain "beliefs" will no doubt form the foundation for a woman's own perspectives and understanding of her pain experience.

## *2.2 Current Labour Pain Theories*

Two opposing theoretical views regarding labour pain and how it should be best managed exist currently. One can be described as a "biomedical" or "medicalised" view, and the other a "midwifery" or "working with pain" view, based on their differing philosophical perspectives of the function of labour pain and how it should be managed. The biomedical view of pain is that it is a sign that things are not right. Therefore, if effective pain relief is available, then it is unnecessary for any woman to experience labour pain [25]. This view advocates for the availability and use of pharmacological interventions to eradicate pain. The working with pain view sees labour pain as a normal part of labour and birth that can be used constructively [26]. This view emphasises the use of (non-pharmacological) resources to support the labouring woman to cope with the sensations of labour. Neither view believes that a woman should suffer during labour and birth. However, the biomedical view assumes that if a woman is in pain then she must be suffering [27], whilst the working with pain view separates pain from suffering and focuses on supporting the woman to cope with the pain of labour [28].

Over the past 50 years in Western societies, the medicalised view of labour pain has dominated. Within this view, labour pain is conceptualised using a tissue-based model that focuses on peripheral contributions to the woman's pain experience: labour pain is described as an "excellent model of acute pain;" that is, one that is clearly attributed to noxious stimulation [29]. Much literature on labour pain within this model emphasises that nociceptive input is the reason for a woman's pain and leaves little space for consideration of non-tissue-based influences [16, 30, 31]. Accordingly, pharmacological management of labour pain that targets the nociceptive input is prioritised. For example, in Wall & Melzack's Textbook of Pain (fifth ed.) over 12 pages is dedicated to describing pharmacological methods of managing labour pain, whilst less than one page discusses non-pharmacological methods. As stated on page 793: "The modern theory of pain management in labour and delivery points out that pain should and must be relieved effectively" [32]. The focus on the eradication of pain in labour is further illustrated by a statement made by the American College of Obstetrics and Gynecology in 2017: "Labor causes severe pain for many women. There is no other circumstance in which it is considered acceptable for an individual to experience untreated severe pain that is amenable to safe intervention while the individual is under a physician's care" [25, p. 766]. In an Australian study, a critical analysis of hospital documents provided to women

described how the use of epidural analgesia during labour is framed as safe whilst the use of water immersion during labour is framed as risky, despite these claims not being supported by evidence [33]. It is clear from examples such as these how pervasive the medical model is. An assumption is made regarding how women understand and relate to their pain during labour, and subsequently how it will be managed, with little space for the possibility of it to be perceived as a productive and purposeful pain.

The opposing working with pain view sees labour pain as central to the process of labour and birth. Within this view, labour pain is described as "functional" pain in that it is "physiological pain felt in a healthy body working well, but at levels of high intensity, beyond usual comfort levels" [34]. The term "functional discomfort" is also suggested as an alternative to labour pain, in order to further differentiate it from pathological pains and the negative connotations associated with the term [35]. Within the working with pain view, it is believed that, given the right environment and circumstances, women possess the capacity to cope with the pain of normal labour.

A key feature of this thinking is that the pain experience is beneficial and various functions of labour pain may include:

- labour pain forces a woman to stop and divert her attention to her body, to recognise that she is about to give birth
- labour pain triggers a woman to summon support
- the challenge of labour pain marks the significance of the occasion—birthing a child
- the discomfort of labour heightens the joy of receiving a baby

At a biochemical level, research has identified that pain plays a vital role in triggering a cascade of neurohormones that optimise the labour process, such as oxytocin [36]. In addition, the production of the body's natural pain-relieving opiates—beta-endorphins—demonstrates that human physiology was designed to attenuate the nociceptive input generated by the woman's labouring body, to facilitate her coping.

It is important to note that a distinction is made between "normal" labour pain, which is that associated with the physiological process of normal labour, and "abnormal" pain, which may be associated with a complication such as labour dystocia or damage to tissues. The working with pain view recognises that abnormal pain may warrant pharmacological intervention. However, during normal labour, the view prioritises non-pharmacological intervention to support the labouring woman. This is justified by the growing body of evidence demonstrating negative effects of pharmacological interventions on hormonally-mediated mechanisms that support and drive labour, breastfeeding and maternal-infant attachment, as well as on mothers' and babies' health and outcomes (See Leap and Anderson [26] and Whitburn et al. [24] for summaries). In promoting normal birth, the view focuses on supporting the labouring woman to engage with, and work through any pain associated with normal labour, rather than trying to take it away. Importantly, the working with pain view emphasises the role of the woman's support people in

helping her cope with her pain: The attitudes and actions of her support people will have a powerful influence on her own perceptions of her pain and ability to cope.

It is clear that each view assumes a different meaning for the pain associated with labour. The medicalised view does not differentiate labour pain from pains associated with pathology, injury, disease or over-applied adaptive changes to the nervous system. The meaning of labour pain is simply associated with nociceptive input from tissue damage, and its management (i.e., to relieve all pain) suggests its redundancy in the process of labour and birth. On the other hand, the working with pain view recognises that labour pain has a different context and function to other pains. Labour pain is functional pain in that it is associated with desirable (if extreme) adaptive tissue changes that occur within a normal physiological event. The working with pain view also acknowledges possible philosophical, social, and personal implications of this pain experience that, from an evolutionary perspective, are important to consider.

Ultimately, we may describe a continuum in which at one end labour pain is viewed as an unnecessary by-product of the labour and birth process that can and should be avoided. At the other end labour pain is viewed as a central component to the transformative process of becoming a mother and has several specific functions. Across the continuum are likely to be mixed, uncertain or ambivalent feelings relating to the role of pain in labour. Recognising these two alternate views regarding labour pain allows us to appreciate the likely social influences that women face prior to, and during, labour and birth. Undoubtedly, these attitudes will subsequently shape the woman's personal meaning for her pain during labour and may set the stage for her interpretations of labour pain as a productive and purposeful pain, or as a threatening pain (Fig. 8.1).

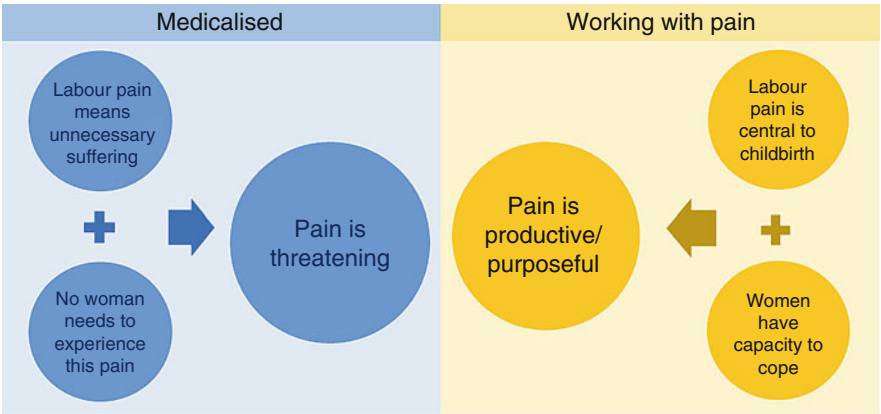


**Fig. 8.1** Opposing theoretical views regarding labour pain and its management. The medicalised or biomedical viewpoint: labour pain is associated with suffering and is unnecessary and something to be avoided; the working with pain viewpoint: labour pain plays a central role in labour and birth and given the right environment and support during a normal labour women possess the capacity to cope. This work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. To view a copy of this license, visit http://creativecommons.org/licenses/by-nc-sa/4.0/

# 3 Factors that Shape the Personal Meaning of Labour Pain

## *3.1 Personal Beliefs*

Deep personal beliefs are rooted in cultural and social perspectives and are also shaped by personal prior experiences. Although the biomedical view dominates in many Western birthing contexts, women will be influenced by their own set of personal experiences, cultural backgrounds, and may hold their own ideas and beliefs, which may go beyond the biomedical tissue-based model. In a study we conducted involving primiparous women, participants were asked, pre-birth, what they thought the function of pain during labour may be [37]. Women's thoughtful responses revealed various theories, including:

Pain as a signal of the normal progress of labour.

> *Maybe it's there (the pain) as a sign that everything is going the way it should be going.* Participant 2203 [37]

The challenge of the pain matches the significance of the event.

> *It's a pretty amazing thing (labour and birth) that's happening so if it was easy then it wouldn't. . .really match up to what you're going through.* Participant 2111 [37]

The challenge of the pain triggering a sense of accomplishment.

> *If somebody wants to climb a mountain it's never going to be easy, it's never going to be painless. But once they've finished they know they've achieved because they've gone through the pain.* Participant 2113 [37]

Pain as a trigger of maternal-child attachment.

> *It could be a strong bonding point with your child, that you've done all this for them. Not in a selfish way, but in. . . that I've gone through this to have you in my life.* Participant 2104 [37]

These responses by women anticipating their first birthing experience demonstrate that despite the dominance of the biomedical model of labour pain, many women seem aware of its limitations in making sense of this unique occurrence of pain.

The personal meaning of pain also has another reference: the woman's prior pain history. Women participating in our research had experienced pain associated with various bony injuries, chronic back pain, kidney stones, a mandible infection, wisdom tooth removal, endometriosis and one even reported being tasered. These experiences can affect the woman's belief about labour pain, her self-efficacy for labour and her approach to managing labour pain. We can access some of the personal meaning about labour pain for women with reference to other painful life experiences by exploring two quotes from our research.

> *It (labour pain) was definitely the worst (physical) pain I've ever experienced. But then, there are worse pains when you're really sick. When I was younger, I was really sick and the intensity of my abdomen pain was scarier because it was an unknown, I was thinking, 'What's going on with me, am I going to die?' Whereas when you're in labour I knew I was in labour and wasn't going to die. So there are worse pains, but labour's pretty bad too.* Participant 8 [38]

> *... I don't like to talk about it as pain like I don't think of it as being in pain, it was a really intense physical experience but I never really thought of it as, yeah, being painful, it just ... you know it took a lot of concentration to get through it and that sort of thing but yeah...* Participant 6 [23]

These two women provide examples of pain being physically intense but not threatening compared to pain associated with illness or injury. In the latter case we also get some insight into the cognitive demand required to cope with the intensity.

Post-birth data reveal an additional interpretation of pain to a labouring woman: Women report using their labour pain to "track" their labour.

> *...you had it in your mind the whole time that the contractions were good even though they were painful it was good because it was sort of tracking your progression.* Participant 2106 [18]

In such cases the meaning of pain to the woman is a sign of the productive work she is doing in labour; that progress is being made. The ability to be consistent and persistent in this interpretation of her body's internal signalling relies on supportive messages from her external environment and, one assumes, a certain amount of resilience.

## 3.2 Cognitive Attributes

By cognitive attributes, we mean the woman's resilience, her persistence with and ability to focus on a task despite adversity and her ability to interpret signals from interoceptors. Over the past two decades research has revealed important clues regarding the role of cognitive attributes in the experience of labour pain. To fully appreciate how many of these cognitive variables influence a woman's pain, we will consider how they contribute to the meaning of the pain to the labouring woman.

### 3.2.1 State of Mind

> *They assessed me and told me that I would need a forceps delivery so they were going to give me an epidural...So then I thought, 'Oh well, the epidural is going to take care of the pain and the contractions now so I can stop focussing. It's going to be easy now'. And as soon as I lost my focus I started getting pain. I became more focussed on the room and the people around me. I was focussing on all the outside stuff instead of focussing on what was going on inside me. I had more of a normal everyday mind.* Participant 12 [23]

A woman's state of mind during labour influences her relationship with the pain and interpretation of it. In a study we conducted in 2014 [23], the women's retelling of labour indicated a shift between two states of mind during their labour: a "mindful acceptance" state and a "distracted and distraught" state. The mindful acceptance state was characterised by women remaining focused in the present moment, on their bodies and on their sensory experiences, without reacting to the experience or judging themselves. When in this state, women appeared to be in tune with their bodies. Importantly, their experience of pain was accepted as one component of their overall experience. This state of mind appeared to have a powerful effect on women coping well with the pain, through this quality of acceptance. It may be that a mindful acceptance state attenuates the pain experience by preventing pain from re-entering an active threat-response system as an additional threatening input. Several other studies have also identified that an attitude of acceptance and "going with the flow" helps women interpret the pain as less threatening and enables them to work with it [39, 40].

A distracted and distraught state was characterised by women not focussing on the present moment or their bodies. Instead, their thoughts included reactive responses (particularly worrying about the pain) and critical judgement of their capacity to cope. A sense of helplessness highlighted this state and resulted in a negative relationship to the pain. Although helplessness may be considered useful in the context of labour—i.e., a recognition of not being able to cope alone that triggers behaviours that summon support—sustained catastrophic thinking may undermine an individual's sense of coping. The distracted and distraught state featured key elements of pain catastrophising, described as an exaggerated negative mindset in relation to an actual or anticipated pain experience. Catastrophising has also been linked in other studies to measures of labour pain intensity, use of pain interventions during labour, and the length of postpartum physical recovery [41, 42].

### 3.2.2 Distractions

Women in our study reported shifting between the two states throughout their labour. They could be pulled out of a mindful acceptance state by distractions in their environment, or by an internally generated loss of focus. This included the sounds and features of the space they were labouring in (e.g., bright lights, the sounds of monitors or clocks on the wall), who was around them and what those present in the room were doing, or their own thought processes triggered by this environmental *noise*.

> *I was focused on not having seen my daughter for 2 days . . . I got distracted and out of my zone.* Participant 8 [23]

An unexpected finding was how some women described that their focus was often drawn to a concern for how their partner was coping. It became apparent from this data, that there was a strong interrelationship between a labouring woman's pain experience and her physical and social environment, and that her own thought

processes, including those related to the care of others, could draw her away from a mind-state beneficial for the progress of labour.

### 3.2.3 Other Life Events

One of the key influences on the development of the cognitive attributes in responses to pain may be the outcomes of prior pain experiences, as outlined in a previous section, and other life learning about pain including parental behaviours [43, 44].

> *My mum was a pretty tough cookie so she . . . I don't know, she was kind of not hesitant but she was kind of like 'Oh you'll be okay, you'll be fine, you'll get over it' kind of thing. And my sister for example broke her arm and my mum didn't think much of it until she complained about it for like quite a few hours and then Mum's like 'Okay, we better get this sorted.' So yeah, Mum and Dad are quite strong and tough. So I think that kind of got passed on to us.*
> Participant 2 (unpublished data)

Yet another factor that potentially shapes women's labour experience are the stories and descriptions provided by childbirth educators and other women, and the increasingly accessible images and recordings available online. Most women do not get to witness a live birth before they have their own experience and so must build a version of what it might be like, drawn from personal accounts of others or edited versions presented in the media.

### 3.2.4 Self-Efficacy for Labour

The imagery of labour presented in the media and online and the personal storytelling, especially by those she views as similar to her, has the potential to strongly influence a woman's self-efficacy. Self-efficacy relates to the belief in one's ability to accomplish a task. In the context of labour, it is a woman's belief in her ability to labour successfully, despite the associated intense sensory and emotional experiences, including pain. Prior self-efficacy for labour has been found to influence a woman's labour pain experience [45]. Higher levels of self-efficacy are associated with persistence despite difficulty and, in labour, reflect that a woman feels she has the necessary cognitive and behavioural resources to manage the pain and so is less likely to rely on passive pain interventions to cope.

A recent study investigating distress and the use of epidural analgesia found that women who were more distressed during pregnancy were more likely to use epidural as their sole tool for pain management [46]. While self-efficacy was not measured, it is possible a distressed woman would self-evaluate her resources and ability to cope as lower than a non-distressed woman. A longitudinal study of primiparous women did measure self-efficacy [45]. While the study found that self-efficacy did not influence pain tolerance (measured as the percentage of time during labour without pain intervention), higher levels did change women's evaluation of the intensity of pain and how distressing the pain was. These findings have recently been supported and extended in a study of more than 200 women using pre- and post-birth measures

of self-efficacy. Additionally, this study reported that women with higher levels of self-efficacy were more likely to use coping strategies during the labour than those with low levels [47].

Self-efficacy has been shown to be shaped by numerous factors. One factor that is particularly critical during labour is that of verbal persuasion. While encouraging and supportive comments can increase self-efficacy, comments interpreted by the woman that she is not coping potentially have the opposite effect. In one of many examples from a qualitative study examining 50 women's labour stories, one woman said: "I was asked eleven times if I wanted drugs. . .it tears away at your self-confidence. . ." [48].

It is possible to draw in on the meaning of pain here. The self-evaluation of the ability to labour successfully, is likely to be different for a woman who is accepting of the pain associated with labour and who views it predominantly as non-threatening, compared to a woman who considers labour pain threatening. It could be speculated the woman with the more accepting, non-threatening view of pain, might consider she needs fewer or more self-regulated resources to cope, and so would have a higher self-efficacy for labour. Importantly, the woman's caregivers can provide implicit or explicit cues to her regarding her capacity to cope, or not, and in doing so can influence both her self-evaluation of coping and the meaning of the pain.

### 3.2.5 Anxiety Sensitivity

Anxiety has long been considered an influence on pain but the role of general anxiety on labour pain seems uncertain. On the other hand, anxiety sensitivity, defined as the belief that anxiety-related symptoms are themselves dangerous or threatening, has been shown to be a strong predictor of labour pain [49, 50]. It could be expected that a woman with high levels of anxiety sensitivity would be hypervigilant for bodily experiences during her labour (e.g., the physical experience of a uterine contraction) and attribute these to negative outcomes (e.g., the subsequent experience of pain), and to interpret them as more dangerous (i.e., the pain is more threatening).

### 3.2.6 Attachment Pattern

A woman's attachment pattern prior to labour has also been demonstrated to influence her experience of labour pain. Attachment is conceptually thought of as the tendency of a person to establish an emotional bond to attachment figures for safety and security [51]. According to attachment theory, childbirth is a significant life event that should activate the attachment system, thus calling upon a woman's attachment tendencies when engaging with her caregivers for support and assistance. Anxious and avoidant attachment patterns have been found to be associated with more severe pain reports and to be predictive of analgesia use [51, 52].

One of the primary purposes of attachment patterns is thought to be the regulation of negative affect. During childbirth, women may use attachment behaviours to manage their emotions and threatening experiences, and subsequently increase their sense of safety. Anxious and avoidant attachment patterns both represent suboptimal cognitions, emotions and attachment behaviours in relation to caregivers, and therefore may heighten the perceived sense of the threat of labour, and thus result in a more threatening pain experience.

Whilst the positive effect of support during labour is well documented, particularly in relation to a woman's ability to reframe her pain and capacity to cope, the emerging data on attachment patterns demonstrate the complexities of how support may be differently perceived by different women.

## *3.3 Coping and Suffering and the Meaning of Labour Pain*

*I remember thinking 'this hurts, but it also feels awesome!'* Participant 15 [23]

In developed countries where labour pain is often conceptualised as a negative pain, pain and suffering are often inextricably linked—a woman experiencing pain during labour is presumed to be suffering. It is claimed that women should not be made to suffer through labour pain and will need to be "rescued" through the implementation of pain interventions. Pain and suffering, however, are separate experiences, and whilst they often co-exist in situations of (particularly extreme) pathological pains, in relation to labour pain this may not always be the case. Consistent findings in the literature demonstrate that women who experience labour pain as a productive and purposeful pain, associated with positive emotions and cognitions, do not describe a sense of suffering. Suffering is often associated with women who feel alone or unsupported during their labour. Chuahorm et al. [6] describes the experiences of Thai women for whom support people are not allowed in the hospital labour room. Women described a sense of helplessness exacerbated by a sense of being alone. Similar findings were reported by Wang [7] regarding women giving birth in Shanghai, China. One participant explained:

> *When I was in pain, I would yell and no one would pay attention. Then by the time it hurt even more severely, I wanted to cry, but not even one tear would come out. Really, at the time I thought I wanted to die. . .Everyone [the nurse-midwives] wanted you to give birth yourself. Any they would just chat, talk to each other, and make jokes. And it was just me, alone, suffering—no one paid attention. At that time, I lost hope because there was not one person to comfort me. I felt like I didn't want to give birth anymore.* Participant Dongmei [7]

It is important to recognise that pain is not sufficient for suffering and instead it is the individual's unique interpretation of their experience, including the perceived impact on physical and emotional wellbeing, meaning and coping resources that determines whether they experience suffering in relation to their pain [27]. As Turk and Wilson [27] explain, "Viewing suffering as an inevitable consequence of pain may unwittingly initiate and reinforce suffering." It may therefore be that the current

approach to viewing and managing labour pain in many Western societies inadvertently contributes to women's suffering.

## 3.4 Pain Context

> *As soon as I found out I'd need a caesarean section it felt more painful because I knew that it wasn't working towards giving birth.* Participant 10 [23]

Interacting with these cognitive attributes of the woman, is the pain context. The context of the woman's pain experience will shape the meaning ascribed to it. Even though all labouring women are proceeding through the same process, which is working towards the birth of a child, this context may be interpreted differently by different women.

For some women, the pain of labour is a signal of labour progressing, is accepted as a normal part of the experience, and for some is even embraced as an opportunity for growth and achievement. The social environment can facilitate this contextual understanding. Caregivers who are known, trusted and calm can facilitate this positive interpretation of the context. A woman's caregivers can help steer her away from pain catastrophising and help her remain in a focussed state of mindful acceptance. Through implicit and explicit actions and words, the context of the pain is represented as leading towards a positive outcome: the birth of a child.

If a woman interprets the context of the pain as not working towards a goal, she is more likely to interpret the pain as threatening. For some women the rate of progression, or the intensity of the pain, does not match their expectations, and is not linked to progression through labour. Thus, the meaning of the pain is that it is a threat to her or her baby's well-being. A prior fear of the pain of labour, or low self-efficacy for labour, can further prime a woman for a negative evaluation of the context of the pain. Caregivers can have a powerful influence over a woman's response to the context. A lack of support can make a woman feel unsafe, heightening the sense of pain as threatening. Alternatively, caregivers who interfere with a woman's focus, or influence her interpretation of the pain through verbal and non-verbal cues, can further increase the pain's threat-value. In our evaluation of women's experiences of labour pain, we found that simply reporting the findings of a cervical dilation assessment could have detrimental effects on a woman's pain evaluation and sense of capacity to cope.

> *When they told me I was 3 cm. . . that's probably the main thing out of my whole labour that really got me. I started crying 'cause I was just so upset because, like, you hear you have to be this many centimetres . . . But I reckon if they were to tell me that no, look, you are 8 cm, this is the pain at 8 cm, I would have been like alright, I'm managing with the gas then.* Participant 2201 [18]

This quote also highlights another important contextual feature: the woman's emotional state. It would seem that losing her focus accompanied by a change in emotional context, may challenge a woman's resilience significantly.

Women's understanding of the context of the pain influences the pain's meaning. A productive and purposeful pain is associated with labour progression, is accompanied by positive cognitions and emotions, and with a supportive and sensitive social environment. A non-productive pain is one that is interpreted as not leading towards the goal, is not embraced as a useful component of the labour, and these messages may be implied by the actions or words of people in the social environment.

### *3.5 Social Environment*

In many of the examples above, we see how the woman's social environment influences each variable, thus shaping her pain experience. Humans are social beings: Our brains are relational organs that drive us to connect with others. In doing so we contextualise, form an understanding of, and identify meanings for, our experiences. Pain is one such experience that is determined by an appraisal of an individual's needs at a time to survive and thrive in the physical and social environment. Pain during labour has strong social uses in driving a labouring woman to seek, and remain engaged with, caregivers. Even maladaptive pain cognitions such as catastrophising may be functioning to enhance the labouring woman's urge to seek help. The emerging role of the endogenous opioid system in socialisation [53] may further reinforce a link between pain and social bonding with carers, above and beyond what is currently realised.

Ultimately, the social context of the woman's pain during labour gives that pain meaning, which then contributes to its place in her labour and birth "story." The people present during a woman's labour are somewhat predetermined by choices she made, or others made, about the safety of her and her baby. However, there are often no guarantees that preferred staff will be there, especially for the duration of labour. Similarly, the preferred personal support people may not always be available or allowed to be present, for example due to restriction of numbers. This is important as it would seem apparent that caregivers and support people have a significant impact on a woman's pain experience. This chapter is not the place to explore or expand on care provision. However, models of midwifery care that provide continuity of care in small teams or via one-to-one midwifery care [54] and culturally informed initiatives such as Birthing on Country [55] can help to provide a supportive social environment that would appear to have many benefits, including for the labour pain experience [56].

## 4 Conclusion

Labour pain is a significant component of the birthing experience of women across the world. However, not all women experience labour pain in the same way. A defining variable in a woman's experience appears to be her interpretation of its meaning. What is this pain telling me? Research suggests that women can view pain as a positive sign of progression of labour, or as a sign of damage and even threat to their life. Importantly, a woman who may go into labour with a strong belief one way or the other can undergo challenges to that belief which may change the course of the experience. As the woman finds her resources to cope depleted or enhanced, the assistance she seeks and the capacity to persevere will likely change. This may be a moment-to-moment proposition and it may transform the birthing process. Our research suggests that it is important for women to think of labour pain as part of a natural physiological process (i.e., purposeful) and a sign of progression towards the birth of her child (i.e., productive). Logically, a woman supported by carers promoting a more physiological approach to pain may maintain a belief that pain is productive and purposeful and would be more likely to persevere with the effort of childbirth and show greater tolerance to the process. Conversely, a woman who has a belief that she or her child are at risk of harm is unlikely to persevere and is more likely to request and agree to medical interventions. Giving birthing women the confidence to acknowledge their pain experience as a sign of progression and to support them to respond by working with the pain, reinforces a meaning of labour pain that is distinct and unique.

In this chapter we have attempted to provide a review of the literature that demonstrates the important relationship between a woman's experience of labour pain and its meaning. We have drawn from our own work, including author Whitburn's doctoral thesis, as well as a broad range of theoretical and empirical literature from numerous contexts, countries and models of health care. However, the complexity of this experience could never be comprehensively explored in one book chapter. Therefore, there will be facets that we have not covered, or only brushed on. This is partly due to the limited available research that explores the concept of the meaning of labour pain.

We hope that future studies further explore the personal attributes and socio-cultural dynamics that shape a woman's pain experience during labour. Due to the subjective nature of pain these ideas must be studied through robust qualitative inquiry. We also hope that the unique nature and context of labour pain helps to expand and improve conceptions and definitions of the human experience of pain and its function.

**Note** Informed consent was obtained from all individual participants included in the study.

## References


1. Rich A. Of woman born: motherhood as experience and institution. London: WW Norton; 1995. 274 p.
2. Corli O, Grossi E, Roma G, Battagliarin G. Correlation between subjective labour pain and uterine contractions: a clinical study. Pain. 1986;26(1):53–60.
3. Lowe NK. Critical predictors of sensory and affective pain during four phases of labor. J Psychosom Obstet Gynaecol. 1991;12(3):193–208.
4. Melzack R, Kinch R, Dobkin P, Lebrun M, Taenzer P. Severity of labour pain: influence of physical as well as psychologic variables. Can Med Assoc J. 1984;130(5):579–84.
5. Lundgren I, Dahlberg K. Women's experience of pain during childbirth. Midwifery. 1998;14 (2):105–10.
6. Chuahorm U, Sripichyakarn K, Tungpunkom P, Klunklin A, Kennedy P. Fear and suffering during childbirth among Thai women. Thai J Nurs Res. 2007;11(1):49–61.
7. Wang E. Requests for cesarean deliveries: the politics of labor pain and pain relief in Shanghai, China. Soc Sci Med. 2017;173:1–8.
8. Beigi NMA, Broumandfar K, Bahadoran P, Abedi HA. Women's experience of pain during childbirth. Iran J Nurs Midwifery Res. 2010;15(2):77.
9. The Holy Bible: new international version. London: Hodder & Stoughton; 2015.
10. Doering K, Patterson J, Griffiths CR. Japanese women's experiences of pharmacological pain relief in New Zealand. Women Birth. 2014;27(2):121–5.
11. Callister LC, Khalaf I, Semenic S, Kartchner R, Vehvilainen-Julkunen K. The pain of childbirth: perceptions of culturally diverse women. Pain Manag Nurs. 2003;4(4):145.
12. Merskey H. Pain terms: a list with definitions and notes on usage. Recommended by the IASP Subcommittee on Taxonomy. Pain. 1979;6:249–52.
13. Williams ACC, Craig KD. Updating the definition of pain. Pain. 2016;157(11):2420–3.
14. Whitburn LY, Jones LE, Davey MA, Small R. Supporting the updated definition of pain. But what about labour pain? [Comment]. Pain. 2017;158(5):990–1.
15. Cohen M, Quintner J, van Rysewyk S. Reconsidering the international association for the study of pain definition of pain. Pain Reports. 2018;3(2):e634.
16. Rowlands S, Permezel M. Physiology of pain in labour. Baillieres Clin Obstet Gynaecol. 1998;12(3):347–62.
17. Visser EJ, Davies S. Expanding Melzack's pain neuromatrix. The threat matrix: a super-system for managing polymodal threats. Pain Pract. 2010;10(2):163.
18. Whitburn LY, Jones LE, Davey MA, Small R. The meaning of labour pain: how the social environment and other contextual factors shape women's experiences. BMC Pregnancy Childbirth. 2017;17:157.
19. Olza I, Leahy-Warren P, Benyamini Y, Kazmierczak M, Karlsdottir SI, Spyridou A, et al. Women's psychological experiences of physiological childbirth: a meta-synthesis. BMJ Open. 2018;8(10):e020347.
20. Reilly P, Macleod I, Macfarlane R, Windley J, Emery R. Dead men and radiologists don't lie: a review of cadaveric and radiological studies of rotator cuff tear prevalence. Ann R Coll Surg Engl. 2006;88(2):116–21.
21. Englund M, Guermazi A, Gale D, Hunter DJ, Aliabadi P, Clancy M, et al. Incidental meniscal findings on knee MRI in middle-aged and elderly persons. N Engl J Med. 2008;359 (11):1108–15.
22. Frank JM, Harris JD, Erickson BJ, Slikker W III, Bush-Joseph CA, Salata MJ, et al. Prevalence of femoroacetabular impingement imaging findings in asymptomatic volunteers: a systematic review. Arthroscopy: J Arthrosc Relat Surg. 2015;31(6):1199–204.
23. Whitburn LY, Jones LE, Davey MA, Small R. Women's experiences of labour pain and the role of the mind: an exploratory study. Midwifery. 2014;30(9):1029–35.

24. Whitburn LY, Jones LE, Davey MA, McDonald S. The nature of labour pain: an updated review of the literature. Women Birth. 2019;32(1):28–38. https://doi.org/10.1016/j.wombi.2018.03.004.
25. Obstetric Analgesia and Anesthesia. Practice bulletin no 177. American college of obstetricians and gynecologists. Obstet Gynecol. 2017;129:e73–89.
26. Leap N, Anderson T. The role of pain in normal birth and the empowerment of women. In: Downe S, editor. Normal childbirth: evidence and debate. Edinburgh: Churchill Livingstone; 2008. p. 29–47.
27. Turk DC, Wilson HD. Pain, suffering, pain-related suffering—are these constructs inextricably linked? Clin J Pain. 2009;25(5):353–5.
28. Leap N, Dodwell M, Newburn M. Working with pain in labour: an overview of evidence. NCT New Digest. 2010;49:22–6.
29. Melzack R. Labour pain as a model of acute pain. Pain. 1993;53(2):117–20.
30. Hess P. Pain in the obstetric patient. In: Elliott JA, Smith HS, editors. Handbook of acute pain management: informa healthcare; 2010. p. 276–91.
31. Brownridge P. The nature and consequences of childbirth pain. Eur J Obstet Gynecol Reprod Biol. 1995;59:S9–S15.
32. Pan PH. Obstetric pain. In: McMahon S, Koltzenburg M, Tracey I, Turk DC, editors. Wall & Melzack's textbook of pain. 6th ed. Philadelphia, PA: Elsevier Health Sciences; 2013. p. 772–93.
33. Newnham EC, McKellar LV, Pincombe JI. Documenting risk: a comparison of policy and information pamphlets for using epidural or water in labour. Women Birth. 2015;28(3):221–7.
34. Dempsey R. Embracing the intensity – celebrating birth as a peak bodily performance. Birth matters. 1998:4–6, 20.
35. Sanders R. Functional discomfort and a shift in midwifery paradigm. Women Birth. 2015;28(3):e87–91.
36. Buckley SJ. Hormonal physiology of childbearing: evidence and implications for women, babies, and maternity care. Washington, DC: Childbirth Connection Programs, National Partnership for Women & Families; 2015. 225 p.
37. Whitburn LY, Jones LE, Davey MA, Small R. First-time mothers in Victoria – a pilot cohort study.
38. Whitburn LY, Jones LE, Davey MA, Small R. Expectations, fears and pain experience: identifying internal and external threats to perceived safety for women in two birthing environments. BMC Pregnancy Childbirth. 2017;17:157.
39. Karlsdottir SI, Halldorsdottir S, Lundgren I. The third paradigm in labour pain preparation and management: the childbearing woman's paradigm. Scand J Caring Sci. 2014;28(2):315–27.
40. Johnson TR, Callister LC, Freeborn DS, Beckstrand RL, Huender K. Dutch women's perceptions of childbirth in the Netherlands. MCN Am J Matern Child Nurs. 2007;32(3):170–7.
41. Flink IK, Mroczek MZ, Sullivan MJL, Linton SJ. Pain in childbirth and postpartum recovery—the role of catastrophizing. Eur J Pain. 2009;13(3):312–6.
42. Veringa I, Buitendijk S, de Miranda E, de Wolf S, Spinhoven P. Pain cognitions as predictors of the request for pain relief during the first stage of labor: a prospective study. J Psychosom Obstet Gynaecol. 2011;32(3):119–25.
43. Kraljevic S, Banozic A, Maric A, Cosic A, Sapunar D, Puljak L. Parents' pain catastrophizing is related to pain catastrophizing of their adult children. Int J Behav Med. 2012;19(1):115–9.
44. Fillingim RB, Edwards RR, Powell T. Sex-dependent effects of reported familial pain history on recent pain complaints and experimental pain responses. Pain. 2000;86(1–2):87–94.
45. Berentson-Shaw J, Scott KM, Jose PE. Do self-efficacy beliefs predict the primiparous labour and birth experience? A longitudinal study. J Reprod Infant Psychol. 2009;27(4):357–73.
46. Jonsdottir SS, Steingrimsdottir T, Thome M, Oskarsson GK, Lydsdottir LB, Olafsdottir H, et al. Pain management and medical interventions during childbirth among perinatal distressed women and women dissatisfied in their partner relationship: a prospective cohort study. Midwifery. 2019;69:1–9.

47. Sánchez-Cunqueiro MJ, Comeche MI, Docampo D. On the relation of self-efficacy and coping with the experience of childbirth. J Nurs Educ Pract. 2018;8(6):48.
48. Rafalovich A. Pain is the club: identity and membership in the natural childbirth community. Qual Sociol Rev. 2016;12(3):100–16.
49. Lang AJ, Sorrell JT, Rodgers CS, Lebeck MM. Anxiety sensitivity as a predictor of labor pain. Eur J Pain. 2006;10(3):263–70.
50. Curzik D, Jokic-Begic N. Anxiety sensitivity and anxiety as correlates of expected, experienced and recalled labor pain. J Psychosom Obstet Gynaecol. 2011;32(4):198–203.
51. Costa-Martins JM, Pereira M, Martins H, Moura-Ramos M, Coelho R, Tavares J. The role of maternal attachment in the experience of labor pain: a prospective study. Psychosom Med. 2014;76(3):221–8.
52. Quinn K, Spiby H, Slade P. A longitudinal study exploring the role of adult attachment in relation to perceptions of pain in labour, childbirth memory and acute traumatic stress responses. J Reprod Infant Psychol. 2015;33(3):256–67.
53. Ballantyne JC, Sullivan MD. Discovery of endogenous opioid systems: what it has meant for the clinician's understanding of pain and its treatment. Pain. 2017;158(12):2290–300.
54. Forster DA, McLachlan HL, Davey MA, Biro MA, Farrell T, Gold L, et al. Continuity of care by a primary midwife (caseload midwifery) increases women's satisfaction with antenatal, intrapartum and postpartum care: results from the COSMOS randomised controlled trial. BMC Pregnancy Childbirth. 2016;16(1):28.
55. Kildea S, Hickey S, Nelson C, Currie J, Carson A, Reynolds M, et al. Birthing on country (in our community): a case study of engaging stakeholders and developing a best-practice Indigenous maternity service in an urban setting. Aust Health Rev. 2018;42(2):230–8.
56. Leap N, Sandall J, Buckland S, Huber U. Journey to confidence: women's experiences of pain in labour and relational continuity of care. J Midwifery Womens Health. 2010;55(3):234–42.

## 3.5 Related publications

The book chapter above was informed by scholarly work that commenced during the research residency at the Judith Lumley Centre. This has included a peer-reviewed research article on women's preferences of pain assessment, which captured cognitive-related and emotion-related information about the pain experience (Jones, Whitburn, Davey, & Small, 2015), a second article concluding the importance of the social environment and meaning of pain to the woman's experience (Whitburn, Jones, Davey, & Small, 2017a), an updated review of the nature of labour pain (Whitburn, Jones, Davey, & McDonald, 2018), a letter to the editor addressing communication about pain (Jones, Whitburn, Davey, & Small, 2016) and a letter to the editor on the need for a definition of pain that is inclusive of labour pain (Whitburn, Jones, Davey, & Small, 2017b). The book chapter also informed a peer-reviewed commentary, reviewing pain assessment in labour with a focus on the meaning of pain (Whitburn & Jones, 2020).

## 3.6 Concluding comments

The Pain and Movement Reasoning Model is designed intentionally to draw the clinician to cognitive, emotional and social factors including thoughts and beliefs. The body of work on labour pain I have completed in collaboration with Dr. Whitburn (see Sections 3.2 and 3.4), confirm the importance of the *central modulation* category of the Pain and Movement Reasoning Model. In particular, it highlights the clinical importance of the meaning attributed to pain and the contextual factors that form the social environment in which pain is felt. The book chapter presented in this chapter, and the associated publications, reinforce the importance of capturing what pain means to a person, when we are assessing their pain experience.

Chapters 1, 2 and 3 have provided a detailed description of the background supporting the use of the Model. The next chapter will focus on the methods of the original research conducted for this thesis.

## 3.7 References


Flink, I. K., Mroczek, M. Z., Sullivan, M. J. L., & Linton, S. J. (2009). Pain in childbirth and postpartum recovery – The role of catastrophizing. *European Journal of Pain, 13*(3), 312-316.

Gifford, L. (1998). Pain, the tissues and the nervous system: A conceptual model. *Physiotherapy, 84*(1), 27-36.

**Jones, L. E.**, Whitburn, L. Y., Davey, M.-A., & Small, R. (2015). Assessment of pain associated with childbirth: Women′ s perspectives, preferences and solutions. *Midwifery, 31*(7), 708-712.

**Jones, L. E.**, Whitburn, L. Y., Davey, M.-A., & Small, R. (2016). Numeric scoring of pain still has value. *Annals of Emergency Medicine, 67*(5), 679-680.

Melzack, R. (2005). Evolution of the neuromatrix theory of pain. The Prithvi Raj Lecture: presented at the third World Congress of World Institute of Pain, Barcelona 2004. *Pain Practice, 5*(2), 85-94.

van Rysewyk, S. (2016). *Meanings of Pain,* Springer. https://doi.org/10.1007/978-3-319-49022-9

van Rysewyk, S. (2019). *Meanings of Pain (Vol. 2),* Springer. https://doi.org/10.1007/978-3-030-24154-4

Whitburn, L. Y., & **Jones, L. E.** (2019). Labour pain. In S. van Rysewyk (Ed.), Meanings of Pain (Vol. 2), pp. 143-162. Springer. https://doi.org/10.1007/978-3-030-24154-4_8

Whitburn, L. Y., & **Jones, L. E.** (2020). Looking for meaning in labour pain: Are current pain measurement tools adequate? *Pain Medicine*.

Whitburn, L. Y., **Jones, L. E.**, Davey, M.-A., & McDonald, S. (2018). The nature of labour pain: An updated review of the literature. *Women and Birth, 32*(1), 28-38.

Whitburn, L. Y., **Jones, L. E.**, Davey, M.-A., & Small, R. (2017a). The meaning of labour pain: how the social environment and other contextual factors shape women's experiences. *BMC Pregnancy and Childbirth, 17*, 157. https://doi.org/10.1186/s12884-017-1343-3

Whitburn, L. Y., **Jones, L. E.**, Davey, M.-A., & Small, R. (2017b). Supporting the updated definition of pain. But what about labour pain? *Pain, 158*(5), 990-991.

# Chapter 4 – Methods

In this chapter I present the background and theory to the development of an education intervention and then describe the methods undertaken for the doctoral research project, exploring the utility of the Pain and Movement Reasoning Model. This is an enhanced description of the study methods eported in the submitted papers (presented in Chapter 5 and Chapter 6). In addition, the chapter includes an important aspect of the proposed research that was unable to be implemented: the experience of patients when practitioners' use of the Model.

## 4.1 Beyond information giving

The doctoral research project involved educating physiotherapists about pain, therefore I open this chapter by examining educational interventions in research settings and concepts of learning. It is important to address approaches to learning, as education interventions in research are often presented as simply, information giving. Research into learning highlights that there are effective strategies and processes, beyond simply providing content, that promote deeper forms of learning. This is especially required when a learner has established a different world view; for example, a biomedical versus biopsychosocial view of pain. It is likely in such cases that education needs to address more than a knowledge gap.

### 4.1.1 Theories of learning

Education that changes the learner's world view has been described by educational theories including transformative learning (Hoggan, 2016; Mezirow, 1997; Mutsaers et al., 2014; Taylor, 2007) or conceptual change learning (Chi, 2008; Chi, Slotta, & De Leeuw, 1994). Transformative learning theory describes two dimensions,

habits of mind and point of *view*, that define a frame of reference. Habits of mind are habitual ways of thinking and influenced by the socio-cultural environment, and points of view are how these ways of thinking are expressed (Mezirow, 1997). Therefore, changing the frame of reference involves transforming either a point of view or the much more stable, habit of mind (Mezirow, 1997).

There has been some criticism about the inclusion of a broad collection of learning experiences that are labelled as transformative learning, and a typology has been proposed to better define and categorise the essential components (Hoggan, 2016). Four outcome types have been described as defining transformative learning: *Worldview* (i.e. change in assumptions, beliefs and values), *Epistemology* (i.e. more discriminating, open and reflective), *Ontology* (i.e. emotionally capable of change) and *Behaviour* (i.e. actions consistent with new perspective) (Hoggan, 2016). These can inform the construction of clear learning outcomes related to breadth, depth and relative stability of the transformation (Hoggan, 2016).

The theory of conceptual change learning emerged from a similar state of ill-defined descriptions of conceptual change in the literature (Chi et al., 1994). Conceptual change learning has been described as learning with the intention to disrupt existing understanding (Moseley & Butler, 2015). That is, it challenges learners to reconceptualise their way of thinking. Conceptual change is determined as being more, or less, difficult, based on the initial ontological category that a concept is thought to belong to – that is *entities*, *processes* or *mental states* – and the ontological category of the desired change (Chi, 2008; Chi et al., 1994). Chi (2008) describes three types of conceptual change. The first, *Belief Revision* is the correction of a single flawed belief. *Mental Model Transformation* is more complex, as a mental model can be made up of multiple flawed beliefs, some which can be considered critical to the mental model. Therefore, Mental Model Transformation is most effective if the critical beliefs are

addressed. The third type of conceptual change is *Categorical Shift* which is the most difficult, especially as the underlying misconception supports the learner's world view (Chi, 2008).

The idea of threshold concepts, which was mentioned in Section 1.1.2, is relevant in this discussion. Threshold concepts can be considered the information or specific understanding that is essential for mastery of a topic (Harden & Laidlaw, 2017b). An example in the understanding of pain, is that pain is an output of a complex processing system. Once you have learned this, you cannot think about pain as being the result of a simple hard-wired process originating in the periphery. This irreversibility is a characteristic of a threshold concept (Harden & Laidlaw, 2017b). A threshold concept is also considered *troublesome*, another characteristic, in that it is not likely that you would come to that conclusion by common sense (Barradell, 2013; Harden & Laidlaw, 2017b). Importantly a threshold concept is transformative, in this example it changes the way you think about, respond to and treat pain (Barradell, 2013; Harden & Laidlaw, 2017b). Finally, it is integrative, in that this new insight allows you to make links – with mood and pain for example – that would otherwise be hidden (Barradell, 2013; Harden & Laidlaw, 2017b).

In accordance with these theories, change in *ways of thinking and practicing* demands thoughtful educational design (Barradell, 2013; Barradell, Barrie, & Peseta, 2018). Experiences that expose the learner to information that contradicts existing beliefs, offers opportunity for autonomous, real-world learning and support critical reflective processes, are likely to be important (Barradell & Peseta, 2018; Chi, 2008; Hoggan, 2016; Moseley & Butler, 2015). These concepts have informed the design of the intervention for the doctoral project reported in Chapters 5 and 6.

### 4.1.2 Educational design

Authentic contexts for learning are important in health professional education (Baldry Currens & Hargreaves, 2010; Harden & Laidlaw, 2017a; O'Brien & Battista, 2019). This enables the effective translation of theory to practice including the accommodation and adaptation required in a complex, unpredictable environment. Time constraints, scope of practice and patient and peer expectations all challenge the application of classroom-based learning into a clinical context. *Situated Learning Theory* considers the importance of the social context in learning and introduces learning concepts such as *communities of practice* and *landscapes of practice* (Herrington & Oliver, 2000; O'Brien & Battista, 2019). This recognises the importance of a social framework of interactions, expectations and boundaries. When designing educational activities for learning clinically-related skills, it would therefore be ideal if a component of that learning takes place within the work setting, with all its challenges, complexity and collegiality.

Blended learning, offering multi-modal approaches to accessing information, provides variation in delivery that promotes engagement (Garrison & Vaughan, 2008; Heinerichs, Pazzaglia, & Gilboy, 2016). With thoughtful design of educational activities, it also allows an active and changing role for the learner, which is more likely to support their learning strengths (Garrison & Vaughan, 2008). One such design is the *flipped classroom*, where directed learning is undertaken by the learner prior to the formal presentation by a topic expert (Herreid & Schiller, 2013; Røe, Rowe, Ødegaard, Sylliaas, & Dahl-Michelsen, 2019). When online elements are presented in this way, asynchronously, learners have control over when to complete the learning activities and can work at their own pace (Herreid & Schiller, 2013). This was an important consideration for the research reported in Chapters 5 and 6.

Reflection is an important part of professional development and professional practice (Mann, Gordon, & MacLeod, 2009; Moon, 2013; White, Fook, & Gardner, 2006). In learning, reflection is seen to be a chance to reinforce memory of content but also make greater sense of it, especially when the reflection occurs within or after a relevant experience (Moon, 2013). In clinical practice, reflection including metacognition, supports the reasoning that leads to formulation and decision-making (Jones, M. A., 2019). Developing a critical reflective practice enhances the clinician's evaluation of information and reduces the negative influence of bias (Jones, M. A., 2019). A reflection activity was built into the education intervention delivered in the project reported in this thesis. This activity, using a *Pain Reasoning Record*, is described in Section 4.2.7.

In my scholarly work, I have incorporated many of these educational concepts and approaches into a framework of skill development in physiotherapy pre-registration training (**Jones, L. E.**, 2016). An adapted version of this framework was used for the education intervention and is illustrated in Figure 4.1.

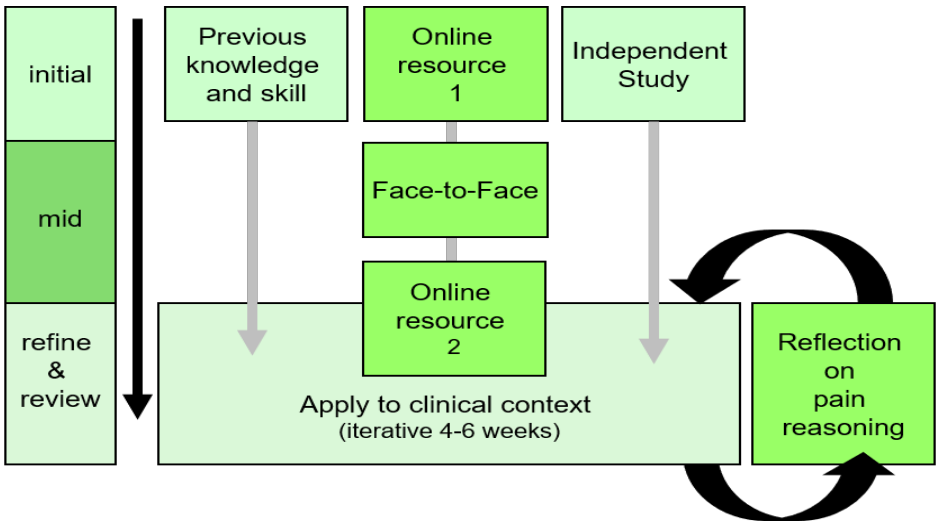


**Figure 4.1** Blended learning process incorporating concepts from reflective practice, flipped classroom approach and situational learning. *(Adapted from Jones 2016 'Beyond information giving: Use of a blended learning approach to reflection to promote skill development in physiotherapy' in A. Peterkin & P. Brett-MacLean (Eds) Keeping Reflection Fresh, Kent State University Press p364)*

## 4.2 Description of methods

### 4.2.1 Design and methodology

In the doctoral research project a concurrent mixed methods design was employed to evaluate the education intervention and the use of the Pain and Movement Reasoning Model (See Table 4.1). Using a concurrent, or convergent, nested mixed methods approach (Collins, Onwuegbuzie, & Jiao, 2007; Doyle, Brady, & Byrne, 2016) the qualitative component of the study, can enhance understanding of the quantitative findings.

The design of the quantitative component was quasi-experimental and involved pre-test and post-test design. The questionnaires and scales used in the study were the Pain Attitudes and Beliefs Scale for Physiotherapists (revised scoring i.e. 19 scored items, PABS-PT), Neurophysiology of Pain Questionnaire (revised 13-item version, NPQ-R) and Patient Practitioner Orientation Scale (PPOS). There was no control group as the population I was drawing from was comparatively small.

The qualitative component involved the use of focus groups and interviews. Drawing on phenomenological methodology, I adopted both a deductive approach, aligned with a pragmatic interpretative framework, and an inductive approach, more aligned to social constructivism. I was influenced by the discussions by Creswell and Poth (2018) comparing different qualitative research approaches, van Manen's philosophical reflections on phenomenology (van Manen, 2016c), Shaw and Connelly's exploration of phenomenology in physiotherapy research (2012) and and the pragmatism offered by Braun and Clarke's commentary on qualitative approaches and thematic analysis (Braun & Clarke, 2006, 2012).

**Table 4.1**

Timepoints for data collection

| | Week 1<br>Start | Week 2<br>Online 1 | Week 3<br>Face-to-Face | Week 4<br>Online 2 | Week 5 - 9<br>Consolidate | Week 10<br>End |
|---|---|---|---|---|---|---|
| Questionnaires | complete | *EDUCATION INTERVENTION (WEEKS 2-9)* | | | | complete |
| Pain reasoning records | | | | | complete | submit |
| Focus groups & interviews | | | | | | participate |

Creswell and Poth (2018) highlighted the differences between phenomenology and other common qualitative methods of inquiry. This reinforced that a phenomenological approach was appropriate to explore participants' lived experience of an education intervention relevant to their clinical practice, and also to explore the use of the Pain and Movement Reasoning Model in physiotherapy. From van Manen (2016a), I took the idea that it is not possible to capture the authentic lived experience, as any attempt to capture it will involve some transformation. Also, with phenomenology, the aim is to use data to create a *collective impression* of the experience being studied (van Manen, 2016a). This, along with Shaw and Connelly's (2012) recommendation to consider multiple approaches to phenomenology in physiotherapy research, liberated my thinking about focusing on a particular approach. The resultant decision was to consider the interpretive process, not as a precise methodology such as interpretative phenomenological analysis, but as a process that can be guided by the data and the researcher, within a set of broad criteria (van Manen, 2016b). Contributing to the design and process was the guidance provided by the consolidated criteria for reporting qualitative research (COREQ) (Tong, Sainsbury, & Craig, 2007).

### 4.2.2 Healthcare networks, local co-ordination and participants

*Healthcare networks.* Northern Health is a network of public hospitals and health service centres located in the northern suburbs of Melbourne, Australia. St. Vincent's Hospital, Melbourne consists of a large public hospital and several healthcare services in the inner city and eastern suburbs of Melbourne, Australia. I refer to Northern Health as Network A and St. Vincent's Hospital Melbourne as Network B. There was no intention to compare findings between the sites.

*Recruitment.* Physiotherapists with a range of experience, working across a range of clinical areas in the two public healthcare networks in Melbourne, Australia were recruited between September 2017 and May 2018. To be eligible for the study, physiotherapists had to work at least two days per week and, to enable their use of the Pain and Movement Reasoning Model, at least some of their patients needed to have pain as part of the clinical presentation. Participants also needed to be available to attend a face-to-face education session occurring in the second or third week of the study period.

A local coordinator was involved at each network and contributed to the local coordination of recruitment and the timing and venues, for a project information session, the face-to-face education, and the focus groups and interviews. This included promoting the project to those working in clinical areas other than musculoskeletal, so that a broad sample could be involved (see Section 6.2.1). The recruitment process involved a face-to-face presentation at each of the network sites to raise awareness of the project and subsequent word-of-mouth dissemination. Those interested contacted the local coordinator and a participant code was allocated to enable de-identified data storage. The process for consent was slightly different between sites due to local preferences and arrangements. Either an email, containing a copy of the presentation

slides, participant information and a consent form (PICF), was sent to the physiotherapist's work email address, or a hard copy of the PICF was provided to those interested. Those still keen to participate, delivered a hard copy of the completed consent form to the local coordinator who then provided hard copies of the pre-intervention questionnaires (see Section 4.2.4).

*Participants.* Physiotherapists from four clinical sites of Network A were recruited in September 2017 and focus groups and interviews were completed by the end of December 2017. Physiotherapists from two sites of Network B were involved from February 2018 to May 2018. A second round of recruitment for physiotherapists working at Network A was completed in an attempt to improve the sample size for the quantitative data collection. This second iteration occurred from April to June 2018 and, due to limitations on the project's end date, no focus groups or interviews were offered for this group of participants.

### 4.2.3 Quantitative Data collection

The timepoints for data collection are presented in Table 4.1. The questionnaires and scales were presented in an eight-page document including a title page, a page of instructions and a final page for additional comments (see Appendix C). Section A was for the collection of characteristics of the physiotherapist and their work, including years of experience, type of practice, clinical area and previous pain education, reflecting previous research (Adillón, Lozano, & Salvat, 2015; Mutsaers et al., 2014; Overmeer, Boersma, Main, & Linton, 2009). Sections B, C, and D contained the reproduced standardised questionnaires, with the longest scale, PABS-PT, presented first, then NPQ-R and finally PPOS. Piloting of the questionnaire document indicated it would take around 15 minutes to complete.

Completed pre-test questionnaires were submitted to the local coordinator prior to the commencement of the education session and completed post-test questionnaires were submitted either to the research assistant running focus groups and interviews, or the local coordinator. Participant codes were used to track submission of questionnaires and to link pre and post submissions.

### 4.2.4 Questionnaires and scales

*Pain Attitudes and Beliefs Scale for Physiotherapists* (PABS-PT) is a commonly used scale, designed to measure attitudes and beliefs of health professionals (Bishop, Thomas, & Foster, 2007; Houben, Gijsen, Peterson, De Jong, & Vlaeyen, 2005a; Houben et al., 2005b) and was the scale used in the sample size calculation for this study (see Section 4.2.5). It has two subscales that are scored independently. The more reliable of these is the *biomedical* subscale which aligns with attitudes and beliefs about pain from a biomechanical or pathoanatomic perspective (Houben et al., 2005b). The second subscale is labelled as *behavioural* and commonly referred to as the biopsychosocial subscale, containing items that reflect a more psychologically informed perspective.

The English-version of the questionnaire supplied by the authors (R. Houben, personal communication, 25th July, 2016) has 36 items but only 19 are used in the scoring: 9 items for the behavioural subscale and 10 for the biomedical subscale (Mutsaers et al., 2014; Overmeer et al., 2009). Items are rated using a six-point scale where ‘1’ equals totally disagree and ‘6’ equals totally agree; which results in a maximum score of 60 for the biomedical subscales and 54 for the behavioural subscale. PABS-PT has shown to have moderate correlation with another commonly used tool measuring similar constructs, HC-PAIRS (Houben et al., 2005b). In two similar studies using the 19-item approach to scoring, physiotherapists scored 41.4, before an education

intervention, and 43.5 afterwards, on the behavioural scale, and 25.9, before, and 17.8 after, on the biomedical scale (Overmeer et al., 2009), and in a multidisciplinary group of health professionals scores changed from 18.6 to 20.1 on the behavioural scale and 38. 3 to 28.9 on the biomedical scale (Wang, Fisher, & Hall, 2018).

One reported issue is that some physiotherapists may already have established a biopsychosocial approach to their reasoning and so show little change in pre- and post-education evaluations (Overmeer et al., 2009). Therefore, when designing the doctoral project, I planned to create a subgroup, a priori, for participants with predominant biomedical attitudes and beliefs about pain, and analyse separately. This subgroup was defined as those who scored above the average on the biomedical subscale, and below the average on the behavioural subscale, in the pre-intervention scoring of the PABS-PT.

The *Revised Neurophysiology of Pain Questionnaire* (NPQ-R) has 13-items which consist of statements about pain (Catley, O'Connell, & Moseley, 2013). It has been used in patient (White, L. D., Summers, & Scott, 2018) and health professional populations (Hush, Nicholas, & Dean, 2018) but only evaluated comprehensively with chronic back pain patients (Catley et al., 2013).

When completing the NPQ-R, participants respond to each statement and indicate if the statement is true or false. There is also an 'undecided' choice to prevent people from simply guessing. Ideally this means that the correct answers indicate a correct belief, the incorrect answers indicate a mistaken belief and undecided suggest an uncertain belief, which gives the tool a diagnostic potential for re-education. However, formal scoring only involves adding the correct answers which are awarded one mark each (Catley et al., 2013). No marks are given for an incorrect answer or an undecided selection which means there is no discrimination in scoring between these two selections. Mean scores for the 13-item NPQ-R, before and after an education

intervention, has been reported in patients as 4.6 before and then 6.3 afterwards (White, L. D. et al., 2018), and for physiotherapy students, reported as a percentage, 56% before (i.e. equivalent of a score of 7.3) and 78% afterwards (i.e. equivalent of a score of 10.1) (Hush et al., 2018).

*Patient-Practitioner Orientation Scale* (PPOS) is a measure of the orientation of an individual to person-centered care (Krupat, Yeager, & Putnam, 2000). It has been validated in practitioners working with people with back pain (Shaw, Woiszwillo, & Krupat, 2012) and used as an outcome measure in education interventions for physical therapy students (Ross & Haidet, 2011) and for clinicians working in a geriatric hospital (Wang et al., 2018). The version provided by the author of the PPOS was modified for this project: the term 'doctor' was changed to 'physiotherapist'.

Three scores can be derived from the PPOS – a total score and then two subscale scores for *sharing* and for *caring*. The *sharing* items reflect a shared approach to communication and decision-making (Krupat, Yeager et al. 2000). The *caring* items reflect attention to the patient's feelings and expectations. It was felt the *caring* subscale was most likely to be important in this doctoral project but all scores were included in analysis.

The items of the PPOS are scored on a six-point scale where '1' is strongly disagree and '6' is strongly agree. Selections of strongly disagree are scored 6 and strongly agree is scored 1, except for three reversed items. A high score indicates an orientation toward patient-centeredness.

As mentioned, previous research has used the PPOS as an outcome measure. In a similar study involving a multidisciplinary group of clinicians (n=18) and an education intervention, mean total scores were reported as 83.7 before and 84.4 afterwards (i.e. total score), 41.3 before and 40.5 afterwards (*sharing* subscale) and 42.4 before and 43.9 afterwards (*caring* subscale) (Wang et al., 2018). Following an education

intervention for physiotherapy students, total scores changed from 81.3 to 85.7, the *sharing* subscale score changed from 39.3 to 44.2 and the *caring* subscale score, from 41.9 to 40.6 (Ross & Haidet, 2011). It is important to note the direction of change in the subscales is inconsistent across these studies, despite an overall increase in the total score and this will be discussed further in Chapters 5 and 8 (see Section 5.3 and 8.2). In the study of physiotherapy students, the authors reported a statistically significant change (Ross & Haidet, 2011). The changes reported in the study of clinicians were not statistically significant change but sample size was small (Wang et al., 2018).

*Engagement score*. As part of the education intervention participants were required to complete a template, the Pain Reasoning Record (see Section 4.2.6). I decided to use the information from the submitted Pain Reasoning Records as a proxy measure of engagement with the education delivered including the application of the Pain and Movement Reasoning Model. A participant's engagement score was calculated using three groups of data: (1) the number of Pain Reasoning Records completed, (2) the number of different days Pain Reasoning Records were completed on, and (3) a rating of the Pain Reasoning Records based on a rubric I developed. The rubric was tested for reliability by involving experienced physiotherapy colleagues at Singapore Institute of Technology and asking them to rate 10 mock records. The rubric allowed for assessment of the level of engagement for each Pain Reasoning Record submitted and the highest score obtained by a participant was used in the calculation of the engagement score.

In order to ensure the three aspects were contributing to the engagement score with some equivalence, the raw scores for each were adjusted so that the maximum raw score for each component was transposed to equal 100. Averaging the sum of the three scores, allowed the maximum engagement score to be 100. Both the raw score and the adjusted score was subsequently used in statistical analysis.

### 4.2.5 Sample size calculation

Sample size for the study was calculated based on published outcomes using the Pain Attitudes and Beliefs Scale for Physical Therapists (PABS-PT). As per convention, alpha = 0.05 and power was 0.80. The calculation used was: $n = f(\alpha/2, \beta) \times 2 \times \sigma 2 / (\mu 1 - \mu 2)2$. From a study investigating University-based training, pre-intervention mean for the behavioural scale of the PABS-PT was 41.4 and post-intervention mean was 43.5 (Overmeer et al., 2009). Standard deviation for the outcome was 5. Using an online calculator the sample size required for this study was calculated at 90. This would provide for an effect size of Cohen's d equaling 0.42 (see Table 4.2). Alternately, for the biomedical subscale of the PABS-PT using data from the same study, pre-intervention was 25.9 and post intervention was 17.8 with standard deviation of 6.3, requiring a

**Table 4.2**

Sample size calculation for PABS-PT Behavioural subscale
*(based on Overmeer et al 2009)*

| | |
|---|---|
| Significance level | 5% |
| Power | 80% |
| Mean outcome in control group | 41.4 |
| Mean outcome in experimental group | 43.5 |
| Standard deviation of outcome | 5 |
| Sample size required | 90 |

**Table 4.3**

Sample size calculation for PABS-PT Biomedical subscale
*(based on Overmeer et al 2009)*

| | |
|---|---|
| Significance level | 5% |
| Power | 80% |
| Mean outcome in control group | 25.9 |
| Mean outcome in experimental group | 17.8 |
| Standard deviation of outcome | 6.3 |
| Sample size required | 10 |

sample size of 10, with a Cohen's d equaling 1.16 (see Table 4.3). The recruitment target was set at 90 participants in order to power the study for both subscales.

### 4.2.6 Qualitative data collection

After at least four weeks for consolidation of learning, participants completed the questionnaires again and were asked to attend a focus group or interview. They were also asked to submit their completed Pain Reasoning Records.

The aim of the focus groups and interviews were to capture the physiotherapists' views and experiences on the education and the utility of the Pain and Movement Reasoning Model. While it can be argued that *focus groups* do not align with phenomenologcal process, that is capturing an individual's viewpoint, they can enhance information when interviewees are sharing similar experiences and where consensus is not sought (Creswell & Poth, 2018). Those who attended *interviews* rather than focus groups were either especially targeted for inclusion because of their work characteristics, including clinical area or years of experience, or were unable to attend a focus group with others, but were keen to contribute.

An experienced independent research assistant, unknown to the participants, was recruited to run the focus groups and interviews to ensure participants felt comfortable to express their views openly. She attended a briefing session on the project and was provided access to the online learning resources, and given opportunity to clarify the content and intent of the *Focus Group and Interview Guide* (see Appendix E). An emphasis was placed on trying to create a discussion in focus groups, rather than a structure around set questions.

At the start of these sessions, participants were asked to restate their participant code as an indication of their participation in the focus group or interview and also to serve as a test recording for sound quality. This recording was saved, with the digital

recordings of the focus groups and interviews, to assist in identifying speakers during the transcribing process. Data files of the recordings were uploaded to a password protected server and deleted from the recorder at the first opportunity.

I listened to all the recorded files comprehensively for familiarisation, before I transcribed them. Transcribing was assisted by Express Scribe Transcription software including the use of a foot control pedal. Complete transcriptions were reviewed against the recordings and any errors or omissions corrected.

### 4.2.7 Education intervention

The education intervention needed to be flexible and relatively brief to accommodate busy clinicians. Concepts and strategies from the education literature including blended learning (Garrison & Vaughan, 2008), reflective practice (Mann et al., 2009; Moon, 2013; White et al., 2006), conceptual change (Chi, 2008; Chi et al., 1994), transformative learning (Hoggan, 2016; Mezirow, 1997; Taylor, 2007), the flipped classroom (Bergmann & Sams, 2012; Heinerichs et al., 2016; Herreid & Schiller, 2013) and situational learning (Lave, 1993; Martin, 2009), were integrated into the design.

The process and components of the education package were based on a framework, previously created to promote the development of clinical skills (Jones 2016). It consisted of an online resource that presented current concepts of pain, a face-to-face session to introduce the Pain and Movement Reasoning Model, and a second online resource with applied examples of using the Model. Following this, participants had the opportunity to consolidate the learning, by documenting pain reasoning on a pre-printed template during clinical encounters (see Section 5.3 for further details of the blended learning process and image of the template and see Appendix D for a more comprehensive description of the educational content). Importantly, the content of the education intervention was informed by what was needed for the participant to use the

Pain and Movement Reasoning Model and did not deliberately, or consciously, address items or concepts contained in the chosen outcome measures of the doctoral research project.

*Online Resource 1.* The aim of the first online resource was to ensure all participants had a basic understanding of pain concepts in order to use the Pain and Movement Reasoning Model. I constructed the resource using licensed software (PebblePad www.pebblepad.co.uk/) provided by La Trobe University. I produced text summaries and integrated readily available online video resources (see Table 4.4), to illustrate key concepts.

Learning outcomes, shared with the participants for this resource, were: to introduce current concepts of pain, to demonstrate the broad influences that affect pain and especially immune/endocrine factors, to highlight the need to consider these broad influences even in those with acute injury, to recognise the role of previous adverse experiences on priming the body's protection system (also see Section 5.3 for learning outcomes).

On submitting their pre-education questionnaires to the local coordinator, participants were able to access the resource through a link sent via their workplace email. The link was first tested by the local coordinator to ensure local firewalls did not block the access. The learning task was designed to take 30 minutes to complete. At the end of the activity, participants were instructed to reflect on how the introduced concepts might be relevant to their day to day clinical practice.

*Face-to-face session at workplace.* About a week after the online resource had been sent a 30 minute face-to-face session was delivered in small to medium sized groups, on-site and at a time agreed by the participant and their manager. The purpose of this session was to introduce the Pain and Movement Reasoning Model including the

**Table 4.4**

Key references and video attributions for Online Resource 1

| Key references cited in the presented text summaries |
|---|
| Denk, F., McMahon, S. B., & Tracey, I. (2014). Pain vulnerability: a neurobiological perspective. *Nature Neuroscience*, 17(2), 192-200. |
| Doidge, N. (2007). The brain that changes itself: Stories of personal triumph from the frontiers of brain science: Penguin. |
| Generaal, E., Vogelzangs, N., Macfarlane, G. J., Geenen, R., Smit, J. H., de Geus, E. J., ... & Dekker, J. (2015). Biological stress systems, adverse life events and the onset of chronic multisite musculoskeletal pain: a 6-year cohort study. *Annals of the Rheumatic Diseases*, annrheumdis-2014-206741. |
| Grace, P. M., Hutchinson, M. R., Maier, S. F., & Watkins, L. R. (2014). Pathological pain and the neuroimmune interface. *Nature Reviews Immunology*, 14(4), 217-231. |
| Hannibal, K.E., & Bishop, M.D. (2014). Chronic stress, cortisol dysfunction, and pain: a psychoneuroendocrine rationale for stress management in pain rehabilitation. *Physical Therapy*, 94(12), 1816-1825. |
| **Video Attributions** |
| *Understanding pain in less than 5 minutes and what to do about it!* By GP Access and Hunter Integrated Pain Service from YouTube used under CC BY-NC_SA 3.0 https://youtu.be/C_3phB93rvI |
| *Pain, Is it all in your mind?* By Silje Endersen Rem TEDx Talks from YouTube used under Standard YouTube Licence. https://youtu.be/tiwmVTScusg |
| *Why Things Hurt* by Lorimer Moseley TEDx Talks from YouTube used under Standard YouTube Licence. https://youtu.be/gwd-wLdIHjs |
| *The Drug Cabinet* in the Brain by David Butler Neuro Orthopaedic Institute from YouTube used under Standard YouTube Licence. https://youtu.be/Gd2NaGZa7M4 |

underpinning concepts and research, the content and organisation of the categories, and how to engage with the gridded triangle. It also allowed an opportunity to share

reflections and address any questions about the information presented in the first online resource.

*Online resource 2.* The second online resource included three case studies demonstrating the use of the Pain and Movement Reasoning Model and again was designed to take 30 minutes to complete (see Appendix D for resource content). The most detailed case was an example involving the assessment of pain in a new patient. This included a narrated PowerPoint presentation and a text version of the script, as well as more detailed notes of explanation. The other examples demonstrated use of the Pain and Movement Reasoning Model for exploring the reasons for a flareup of pain, and for use as a device in patient education. This resource also contained a file with the slides from the face-to-face presentation.

*Pain Reasoning Records.* To consolidate this learning, participants were asked to complete Pain Reasoning Records (which I devised for this project) during their clinical encounters. Pain did not need to be the primary complaint. The template for the Pain Reasoning Records was provided on a 25 sheet A5 pad and incorporated the gridded triangle of the Pain and Movement Reasoning Model (see Section 5.3). There were additional blocks on the page for clinical information (e.g. pathology or condition) and decision notes including supporting rationale. Participants were encouraged to complete 4 or 5 records per week and could request an additional 25 sheet pad if they ran out. They were provided with an A4 envelope to store completed records. At the completion of the consolidation phase (~5 weeks) participants submitted their Pain Reasoning Records in an envelope to the local coordinator.

### 4.2.8 Quantitative data analysis

Data from questionnaires, including scores from individual items, and the components of the engagement score were entered into SPSS Version 26. Descriptive

statistics were run for all variables and data checking and cleaning completed. Pre- and post-test comparisons were done for questionnaires and scales using paired t-tests where variables satisfied the assumptions, alternatively Wilcoxon non-parametric comparison of medians was performed when the assumption of normality was violated. In line with the study objectives, a dataset was created of participants with above average PABS-PT biomedical scores and below average behavioural scores, for separate analysis including one-way ANOVA. Correlation and simple regression analyses were performed to identify if some of the recorded physiotherapists' personal or work characteristics contributed to significant findings from the pre-test and post-test analyses.

### 4.2.9 Qualitative data analysis

Transcriptions of the focus groups and interviews were uploaded to a qualitative analysis software package (NVivo 12, QSR) and case files created for all those who participated. The order of selecting transcripts for coding was based on variation (i.e. chronology of recording, different sites, clinical area of participants, focus groups and interviews) to establish a broad list of codes early in the process (Saldaña, 2015).

I adopted Braun and Clarke's (Braun & Clarke, 2006, 2012) instruction on employing thematic analysis, that is systematic, that can be deductive and inductive, and allows identification of patterns of responses relevant to answering the research question or questions . For analysis, the pain experience was considered as a complex dynamic process with individual meaning (see Chapter 3) and as part of the body's highly evolved protection system, that involves integrated neuro-immune-endocrine mechanisms (see Chapter 2).

For evaluation of the education package a more deductive approach was taken, whereas, for the anaysis of the use of the Pain and Movement Reasoning Model, a more

interpretive/inductive approach was used. Multiple codes were applied to the same transcript segment when appropriate. A codebook was established and updated as codes evolved or became redundant as the analysis progressed (see Appendix F). Fewer new codes were required as coding progressed and no new codes were added for the last few transcripts which indicated data saturation. The process was guided by the research aims, enabling two unique sets of codes to be identified one relating to improving pain literacy in physiotherapy, and one focused on the suitability and utility of the Model. There were also a number of codes that were common to both sets. The codes were then reviewed and refined again, as necessary, and then clustered into categories from which themes related to the research aims could be identified. Coding trees were developed to represent this (see Section 5.3 and 6.4).

The final discussion and review of these analyses was completed in consultation with Professors Amir and Kent and I presented the results to a group of participants at Network B for their feedback. This added to the trustworthiness of the qualitative data (Nowell, Norris, White, & Moules, 2017).

## 4.3 Patient perceptions of person-centred care

As part of the evaluation of the utility of the Pain and Movement Reasoning Model, we planned to include the perspectives of patients. This is important as the main purpose addressing clinical reasoning is to improve patient experiences and outcomes. The intention was to use a tool to measure the patient centredness of interactions with the participant physiotherapists from the patient perspective. I planned to use the *Individualised Care Scale* as it had been shown to be valid and reliable including translated versions, in languages additional to English (Suhonen, Leino-Kilpi, & Välimäki, 2005; Suhonen et al., 2012; Suhonen, Schmidt, & Radwin, 2007). This was particularly important as the recruitment sites had patient populations with diverse language groups.

The scales were sourced or translated to include Arabic, Cantonese, Greek, Italian, Mandarin, Turkish and Vietnamese languages. Internal funding was obtained from the Social Research Assistance Platform to assist with this process, and certification of translations was obtained as per Human Research Ethics Committee advice. However, an additional requirement came back from the Committee requiring the Participant Information and Consent Form to be translated also. As the project was not targeting particular language groups, this would require translating documents just in case someone from a particular language group was recruited. This was also not in the scope of the budget for the project and so it was decided, reluctantly to only recruit patients with a level of English adequate to complete the questionnaire.

Co-planning with the local co-ordinators and managers identified differences in preference for patient recruitment. Co-ordinating staff at Network A suggested a process they had used previously, where the participant physiotherapists recruited the patient. Staff at Network B, did not want the burden of recruiting patients put on their staff and were keen to negotiate the patient component out of the process altogether. This decision was delayed initially as research did not commence at Network B until several months after the commencement at Network A.

There was also some negotiation as to how patients would be involved. It was considered too difficult, and perhaps too confronting, to capture a before education and after education measure from the same patient. This was due to the short duration of some physiotherapy interactions especially in-patient care. Therefore, it was decided to sample a group of patients being seen by participant physiotherapists before the education intervention and then sample a different group of patients being seen by participant physiotherapists after education. The average questionnaire scores from each group would then be used to identify changes in perceived patient centredness.

The first task for participant physiotherapists was to recruit patients, provide them with the questionnaire and a stamped and addressed envelope for return to the research team. It became apparent very early that recruitment was proving difficult. This was largely due to a high proportion of patients who did not have an adequate level of English, but also, within focus groups, physiotherapist participants raised other issues. These issues included patients who were willing to be involved until they were asked to sign the consent form, and confusion by some participant physiotherapists as to the process (e.g. only considering patients with 'chronic' pain or only patients they had used the Pain and Movement Reasoning Model with).

With a number of challenges arising, it was decided to abandon this attempt to include a patient voice. This meant the project ran at the Network B without any patient recruitment, which was the initial preference of the co-ordinating staff at that site.

## 4.4 Ethics review and local governance

This study was approved by the Austin Health Human Research Ethics Committee (HREC) on 25th August 2017 and subsequently endorsed by the La Trobe College of Science, Health and Engineering Human Research Ethics Sub-Committee on 29th August 2017. Governance processes, including Research Agreements with La Trobe University, were completed at Northern Health (10th October 2017) and St. Vincent's Hospital Melbourne (6th February 2018). At Northern Health this included establishing an honorary research appointment for me. See Appendix A for all approvals.

## 4.5 References


Adillón, C., Lozano, È., & Salvat, I. (2015). Comparison of pain neurophysiology knowledge among health sciences students: A cross-sectional study. *BMC Research Notes, 8*, 592. https://doi.org/10.1186/s13104-015-1585-y

Baldry Currens, J., & Hargreaves, J. (2010). Situated learning in practice. In L. McAllister, M. Paterson, J. Higgs, & C. P. Bithell (Eds.), *Innovations in Allied Health Fieldwork Education*, pp. 121-130. Rotterdam, The Netherlands: Brill Sense.

Barradell, S. (2013). The identification of threshold concepts: A review of theoretical complexities and methodological challenges. *Higher Education, 65*(2), 265-276.

Barradell, S., Barrie, S., & Peseta, T. (2018). Ways of thinking and practising: Highlighting the complexities of higher education curriculum. *Innovations in Education and Teaching International, 55*(3), 266-275.

Barradell, S., & Peseta, T. (2018). Integrating threshold concepts and ways of thinking and practising: Supporting physiotherapy students to develop a holistic view of the profession through concept mapping. *International Journal of Practice-based Learning in Health and Social Care, 6*(1), 24-37.

Bergmann, J., & Sams, A. (2012). *Flip Your Classroom: Reach Every Student in Every Class Every Day*, Eugene, Oregon, USA: International Society for Technology in Education.

Bishop, A., Thomas, E., & Foster, N. E. (2007). Health care practitioners' attitudes and beliefs about low back pain: A systematic search and critical review of available measurement tools. *Pain, 132*(1-2), 91-101.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Braun, V., & Clarke, V. (2012). Thematic Analysis. In H. Cooper, P. M. Camic, D. L. Long, A. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA Handbook of Research Methods in Psychology, Vol 2: Research designs: Quantitative, Qualitative, Neuropsychological, and Biological*, pp. 57-71. Washington DC, USA: American Psychological Association.

Catley, M. J., O'Connell, N. E., & Moseley, G. L. (2013). How good is the neurophysiology of pain questionnaire? A Rasch analysis of psychometric properties. *The Journal of Pain, 14*(8), 818-827.

Chi, M. T. H. (2008). Three types of conceptual change: Belief revision, mental model transformation, and categorical shift. In S. Vosniadou (Ed.), *Handbook of Research on Conceptual Change*, pp. 89-110. Hillsdale, New Jersey: Erlbaum.

Chi, M. T. H., Slotta, J. D., & De Leeuw, N. (1994). From things to processes: A theory of conceptual change for learning science concepts. *Learning and Instruction, 4*(1), 27-43.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches* (4th ed.). Thousand Oaks, California, USA: SAGE Publications.

Garrison, D. R., & Vaughan, N. D. (2008). *Blended Learning in Higher Education: Framework, Principles, and Guidelines*, San Francisco, California, USA: Jossey-Bass.

Harden, R. M., & Laidlaw, J. M. (2017a). The apprenticehip, community-based education, longitudinal clinical clerkships and work-based learning. *Essential Skills for a Medical Teacher: An Introduction to Teaching and Learning in Medicine* (2nd ed.), pp. 135-143. London, UK: Elsevier.

Harden, R. M., & Laidlaw, J. M. (2017b). Responding to information overload and building options into a core curriculum with threshold concepts *Essential Skills for a Medical Teacher: An Introduction to Teaching and Learning in Medicine* (2nd ed.), pp. 145-158. London, UK: Elsevier.

Heinerichs, S., Pazzaglia, G., & Gilboy, M. B. (2016). Using flipped classroom components in blended courses to maximize student learning. *Athletic Training Education Journal, 11*(1), 54-57.

Herreid, C. F., & Schiller, N. A. (2013). Case studies and the flipped classroom. *Journal of College Science Teaching, 42*(5), 62-66.

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational technology research and development, 48*(3), 23-48.

Hoggan, C. D. (2016). Transformative learning as a metatheory: Definition, criteria, and typology. *Adult Education Quarterly, 66*(1), 57-75.

Houben, R. M. A., Gijsen, A., Peterson, J., De Jong, P. J., & Vlaeyen, J. W. S. (2005a). Do health care providers' attitudes towards back pain predict their treatment recommendations? Differential predictive validity of implicit and explicit attitude measures. *Pain, 114*(3), 491-498.

Houben, R. M. A., Ostelo, R. W. J. G., Vlaeyen, J. W. S., Wolters, P. M. J. C., Peters, M., & Stomp-van den Berg, S. G. (2005b). Health care providers' orientations towards common low back pain predict perceived harmfulness of physical activities and recommendations regarding return to normal activity. *European Journal of Pain, 9*(2), 173-183.

Hush, J. M., Nicholas, M., & Dean, C. M. (2018). Embedding the IASP pain curriculum into a 3-year pre-licensure physical therapy program: Redesigning pain education for future clinicians. *Pain Reports, 3*(2). https://doi.org/10.1097/PR9.0000000000000645

**Jones, L. E.** (2016). Beyond information giving: Use of a blended approach to reflection to promote skill development in physiotherapy. In A. Peterkin & P. Brett-Maclean (Eds.), *Keeping Reflection Fresh*, pp. 363-367. Kent, Ohio: Kent State University Press.

Jones, M. A. (2019). Clinical reasoning: fast and slow thinking in musculoskeletal practice. In M. A. Jones & D. A. Rivett (Eds.), *Clinical Reasoning in Musculoskeletal Practice* (2nd ed.), pp. 2 -31. Sydney, Australia: Elsevier.

Krupat, E., Yeager, C. M., & Putnam, S. (2000). Patient role orientations, doctor-patient fit, and visit satisfaction. *Psychology and Health, 15*(5), 707-719.

Lave, J. (1993). Situating learning in communities of practice. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on Socially Shared Cognition,* pp. 17-36. Washington, DC: American Psychological Association.

Mann, K., Gordon, J., & MacLeod, A. (2009). Reflection and reflective practice in health professions education: A systematic review. *Advances in Health Sciences Education, 14*(4), 595-621.

Martin, C. (2009). Relevance of situational context in studying learning as changing participation. *Scandinavian Journal of Educational Research, 53*(2), 133-149.

Mezirow, J. (1997). Transformative learning: Theory to practice. *New Directions for Adult and Continuing Education,* 74, 5-12.

Moon, J. A. (2013). *Reflection in Learning and Professional Development: Theory and Practice*, London, UK: Routledge.

Moseley, G. L., & Butler, D. S. (2015). Fifteen years of explaining pain: The past, present, and future. *The Journal of Pain, 16*(9), 807-813.

Mutsaers, J.-H., Pool-Goudzwaard, A., Ostelo, R., Peters, R., Koes, B., & Verhagen, A. (2014). The psychometric properties of the PABS-PT in neck pain patients: A validation study. *Manual Therapy, 19*(3), 208-214.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16(1). https://doi.org/10.1177/1609406917733847.

O'Brien, B. C., & Battista, A. (2019). Situated learning theory in health professions education research: a scoping review. *Advances in Health Sciences Education, 25*, 483-509. https://doi.org/10.1007/s10459-019-09900-w

Overmeer, T., Boersma, K., Main, C. J., & Linton, S. J. (2009). Do physical therapists change their beliefs, attitudes, knowledge, skills and behaviour after a biopsychosocially orientated university course? *Journal of Evaluation in Clinical Practice, 15*(4), 724-732.

Røe, Y., Rowe, M., Ødegaard, N. B., Sylliaas, H., & Dahl-Michelsen, T. (2019). Learning with technology in physiotherapy education: Design, implementation and evaluation of a flipped classroom teaching approach. *BMC Medical Education, 19*, 291. https://doi.org/10.1186/s12909-019-1728-2

Ross, E. F., & Haidet, P. (2011). Attitudes of physical therapy students toward patient-centered care, before and after a course in psychosocial aspects of care. *Patient Education and Counseling, 85*(3), 529-532.

Saldaña, J. (2015). *The Coding Manual for Qualitative Researchers*, London, UK: Sage.

Shaw, J. A., & Connelly, D. M. (2012). Phenomenology and physiotherapy: Meaning in research and practice. *Physical Therapy Reviews*, 17(6), 398-408.

Shaw, W. S., Woiszwillo, M. J., & Krupat, E. (2012). Further validation of the Patient-Practitioner Orientation Scale (PPOS) from recorded visits for back pain. *Patient Education and Counseling, 89*(2), 288-291.

Suhonen, R., Leino-Kilpi, H., & Välimäki, M. (2005). Development and psychometric properties of the Individualized Care Scale. *Journal of Evaluation in Clinical Practice, 11*(1), 7-20.

Suhonen, R., Papastavrou, E., Efstathiou, G., Tsangari, H., Jarosova, D., Leino-Kilpi, H., . . . Merkouris, A. (2012). Patient satisfaction as an outcome of individualised nursing care. *Scandinavian Journal of Caring Sciences, 26*(2), 372-380.

Suhonen, R., Schmidt, L. A., & Radwin, L. (2007). Measuring individualized nursing care: assessment of reliability and validity of three scales. *Journal of Advanced Nursing, 59*(1), 77-85.

Taylor, E. W. (2007). An update of transformative learning theory: A critical review of the empirical research (1999–2005). *International Journal of Lifelong Education, 26*(2), 173-191.

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care, 19*(6), 349-357.

van Manen, M. (2016a). Human science methods: Empirical and reflective activities. *Phenomenology of Practice: Meaning-giving Methods in Phenomenological Research and Writing*, pp. 264-290. New York: Routledge.

van Manen, M. (2016b). Issues of logic. *Phenomenology of Practice: Meaning-giving Methods in Phenomenological Research and Writing*, pp. 291- 302. New York: Routledge.

van Manen, M. (2016c). *Phenomenology of Practice: Meaning-giving Methods in Phenomenological Research and Writing*, New York: Routledge.

Wang, A. P., Fisher, G., & Hall, J. (2018). Pain education for clinicians in geriatrics: A study into changes in clinician attitudes and beliefs. *Health Education in Practice, 1*(1), 51-68.

White, L. D., Summers, P., & Scott, A. (2018). Changes in clinical status after completion of an interdisciplinary pain management programme incorporating pain neurophysiology ducation. *Physiotherapy Canada, 70*(4), 382-392.

White, S., Fook, J., & Gardner, F. (2006). *Critical Reflection in Health and Social Care*, London, UK: McGraw-Hill Education.

# Chapter 5 – Improving pain literacy

## 5.1 Introduction to submitted work

The submitted work presented in this chapter is the first empirical research paper reporting on my doctoral research project. It focuses on the effect of an education intervention, incorporating the Pain and Movement Reasoning Model (see Figure 5.1), on pain literacy. I have defined pain literacy as the ability to apply contemporary concepts of pain in clinical practice. I have operationalised it using measures of pain neurophysiology knowledge, attitudes and beliefs about pain and person centredness, along with evidence from focus groups of application of these to the clinical setting.

### 5.1.1 Objectives for this study

- To measure the effect of an education package, incorporating the Pain and Movement Reasoning Model, on improvement of pain knowledge, attitudes and beliefs in physiotherapists working with people with painful conditions.
- To identify changes in perceived person-centred care, in response to an education package incorporating the Pain and Movement Reasoning Model, from the perspective of physiotherapists and their patients.

### 5.1.2 Research questions for this study:

- Does training in the use of the Pain and Movement Reasoning Model alter attitudes and beliefs about pain in those with predominantly biomedical attitudes and beliefs about pain?
- Does training in the use of the Pain and Movement Reasoning Model improve the person-centeredness of clinical interactions in those who initially hold predominantly biomedical attitudes and beliefs about pain?

- Does training in the use of the Pain and Movement Reasoning Model improve knowledge about neurophysiology of pain in physiotherapists?

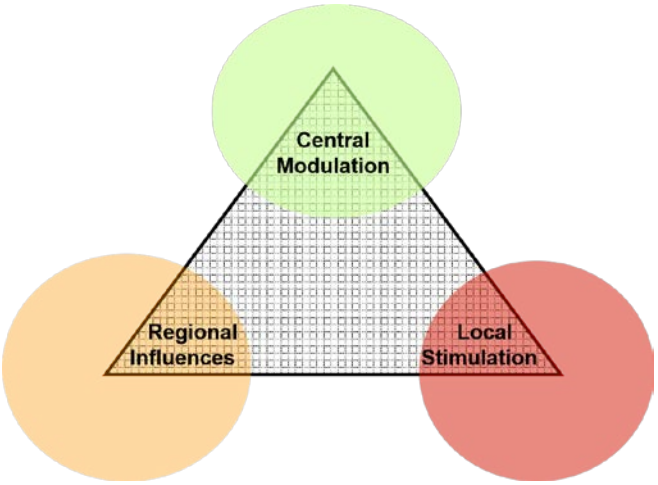


**Figure 5.1** Pain and Movement Reasoning Model

*Authors: Des O'Shaughnessy & Lester Jones*
*(licensed under a Creative Commons Attribution-NonCommercial 3.0 Unported License)*

## 5.2 Additional comment on methods

### 5.2.1 Quantitative data analysis

The three outcome measures, the Neurophysiology of Pain Questionnaire (revised, NPQ-R), Pain Attitudes and Beliefs for Physical therapists (PABS-PT) and Patient-Practitioner Orientation Scale (PPOS), are described in Section 4.2.4. Data were collected at two time points (see Table 4.1). Scoring instructions were followed to obtain subscale scores and total scores. These scores were then considered as ratio data for the statistical analyses performed using SPSS version 26.0 (IBM). For the NPQ, the percentage of correct scores was also calculated and used in analysis similar to a recent study investigating the effect of a specifically designed curriculum on pain knowledge in physiotherapy students (Hush, Nicholas, & Dean, 2018).

There were several factors which impacted on the statistical analysis. The planned sample size of 90 participants was not achieved because of a lower than anticipated recruitment rate – particularly at Network A. Therefore, the data available for comparison of pre- and post-education scores were as low as 58 participants on the NPQ-R and 59 on the other scales. Eight of the 70 participants did not submit post-education questionnaires. Other missing data occurred across items randomly. Notably, the planned subset of participants with predominantly biomedical attitudes and beliefs to pain, consisted of only 17 participants. To allow for the inclusion of more cases in analysis, missing data was managed by deleting cases only for the analysis of variables where the data was missing (i.e. pairwise). While this allows maximum inclusion of data, it negatively impacts the more complex analytical processes (Marston, 2010). Statistical tests were applied to data only when assumptions were not violated. Given the low sample size and the pairwise deletion of missing data, post-hoc data transformation was not considered appropriate.

### 5.2.2 Qualitative data analysis

Drawing on phenomenological approaches, the focus groups and interviews were semi-structured and allowed for open discussion, in order to record the participants' experience of the education intervention (Appendix E). Analysis was predominantly deductive, as defined by Patton (2014), where decisions and responses to data were framed by the research questions, that is in terms of attitudes and beliefs, knowledge and person-centeredness, and the Pain and Movement Reasoning Model. This is a pragmatic approach to analysing what the participants are reporting and how their comments align with the research questions. In addition, I used a more inductive approach where, without preconceived notions, I explored how the participants interacted with and evaluated the education and how it influenced their clinical practice.

This enabled a more constructivist approach to interpreting the participants' experience of the educational design and delivery (see codebook in Appendix F),

## 5.3 Contributions

| CrediT author statement | |
|---|---|
| Lester E. Jones (65%) | • Conceptualisation<br>• Literature review<br>• Methodology<br>• Formal analysis<br>• Data curation<br>• Project administration<br>• Writing – original draft<br>• Writing – review and editing |
| Lisa H. Amir (15%)<br>*(Primary supervisor 2017-2020)* | • Conceptualisation<br>• Methodology<br>• Formal analysis<br>• Project administration<br>• Writing – review and editing |
| Stephen Kent (10%)<br>*(Co-supervisor 2014-2020)* | • Conceptualisation<br>• Methodology<br>• Formal analysis<br>• Writing – review and editing |
| Hazel Heng (5%) | • Methodology<br>• Investigation<br>• Project administration<br>• Writing – review and editing |
| Sophie Heywood (5%) | • Methodology<br>• Investigation<br>• Project administration<br>• Writing – review and editing |

## 5.4 Submitted work *(redacted in this version)*

**Jones, L. E.**, Heng, H., Heywood, S., Kent, S., & Amir, L. H. (submitted). Improving pain literacy in the workplace using the Pain and Movement Reasoning Model: A mixed methods study of physiotherapists.

This paper was submitted to peer reviewed journal on the 1st April 2020. The processing of the manuscript by the journal was initially delayed, due to unforseen circumstances, but at the time of submission of this thesis the manuscript status is *under review*.

## 5.5 Related publications and presentations

A skills development process that I had developed for the learning of clinical skills, informed the development of the education intervention for this study (Jones, 2016). I incorporated concepts and strategies from the education literature and assumed that learners brought unique knowledge to the learning situation. Learners were then able to develop skills through an iterative process integrating reflection and feedback (see 'Figure 1' in submitted paper in Section 5.3). I wrote a report of this which was published in an edited book that offered a practical guide for clinical educators (Peterkin & Brett-Maclean, 2016). Around the same time, I was developing the education intervention for this doctoral research project and so adopted the basic structure of the skills development process, as a framework for the education intervention.

The Pain and Movement Reasoning Model has been delivered to physiotherapists in professional development courses and used to help introduce learner physiotherapists, in pre-registration and post-registration training, to the complexity of pain (see Table 5.1). These presentations helped to conceptualise the content delivered within the education intervention.

Aspects of this study have been presented at national and international conferences. This includes presenting the study protocol (PAS 2018), the planned education intervention (WCPT-AWP 2017), the delivered education intervention (WCPT 2019, APMEC 2019) and selected findings from the study (WCPT 2019).

**Table 5.1**

Presentations of Pain and Movement Reasoning Model

| Conferences/Courses | Selected examples |
|---|---|
| Professional development | The assessment and treatment of pain in clinic practice (Australian Physiotherapy Association) |
| | Pain in Survivors of Torture (Victorian Foundation for the Survivors of Torture) |
| | Annual Winter breakfast, Victorian Branch (Australian Physiotherapy Association) |
| | Annual bring-a-long dinner New South Wales Branch (Australian Physiotherapy Association) |
| | Post-surgical pain (SingHealth Postgraduate Allied Health Institute, Singapore) |
| | Labour pain (National University Hospital, Dept. of Obstetrics & Gynaecology, Singapore) |
| | Pain and Movement Reasoning Model (Nepal Physiotherapy Association) |
| | Pain and Movement Reasoning Model (Ashok & Rita Patel Institute of Physiotherapy, India) |
| Pre-registration (includes undergraduates & graduate-entry Master's students enrolled in pre-registration training) | St. George's University of London (physiotherapy) |
| | University of Melbourne (physiotherapy) |
| | La Trobe University (physiotherapy) |
| | Monash University (physiotherapy) |
| | Australian Catholic University (midwifery students) |
| | Singapore Institute of Technology (physiotherapy) |
| Post-registration (this includes registered health professionals enrolled in formal education) | University of Melbourne (physiotherapy/psychiatry) |
| | La Trobe University (physiotherapy) |

## 5.6 Concluding comments

This brief education intervention resulted in modest changes to questionnaire scores indicative of improved pain literacy. The focus group and interview data indicate the education intervention was well received and the blended approach to delivery allowed participants some flexibility in completing learning tasks. The Pain Reasoning Records were completed at a lower rate than anticipated but were a valuable prompt for reflective practice. A revision of the design of the Records, including an online version, and the inclusion of reminders in the research design, may improve the number of returned Records. These findings provide support for the delivery of similar education interventions in the workplace. In the future, the face-to-face sessions need to be well planned to ensure efficient use of the educator's time and, ideally, a mechanism for providing timely feedback to learners' needs to be developed.

## 5.7 References


Hush, J. M., Nicholas, M., & Dean, C. M. (2018). Embedding the IASP pain curriculum into a 3-year pre-licensure physical therapy program: Redesigning pain education for future clinicians. *Pain Reports, 3*(2). https://doi.org/10.1097/PR9.0000000000000645

**Jones, L. E.** (2016). Beyond information giving: Use of a blended approach to reflection to promote skill development in physiotherapy. In A. Peterkin & P. Brett-Maclean (Eds.), *Keeping Reflection Fresh*, pp. 363-367. Kent, Ohio: Kent State University Press.

**Jones, L. E.**, Heng, H., Heywood, S., Kent, S., & Amir, L. H. (submitted). Improving pain literacy in the workplace using the Pain and Movement Reasoning Model: A mixed methods study of physiotherapists.

Marston, L. (2010). *Introductory Statistics for Health and Nursing*, London, UK: SAGE Publications.

Patton, M. Q. (2014). Qualitative Research & Evaluation Methods: Integrating Theory and Practice, Thousand Oaks, USA: SAGE publications.

Peterkin, A., & Brett-Maclean, P. (2016). *Keeping Reflection Fresh*, Kent, Ohio: Kent State University Press.

# Chapter 6 – Suitability and utility of the Model

## 6.1 Introduction to submitted work

The submitted work presented in this chapter is the second empirical research paper reporting on my doctoral research project. It focuses on physiotherapists' use of the Pain and Movement Reasoning Model (see Figure 6.1). I wanted to determine if physiotherapists felt the integrated biopsychosocial way of thinking and practicing supported by the Model was suitable to their established approach to physiotherapy, and also if they felt there were benefits from using the Model. In order to capture this information, participants first needed training in the use of the Model (see Chapter 5) and then given an opportunity to apply the Model in the clinical context in which they normally work.

### 6.1.1 Objectives for this study

- To examine physiotherapists' perceptions of the utility and suitability of the Pain and Movement Model across a range of clinical contexts.

### 6.1.2 Research questions for this study:

- In what ways do physiotherapists, from a range of clinical contexts, find the Pain and Movement Reasoning Model appropriate for and beneficial to their clinical practice?

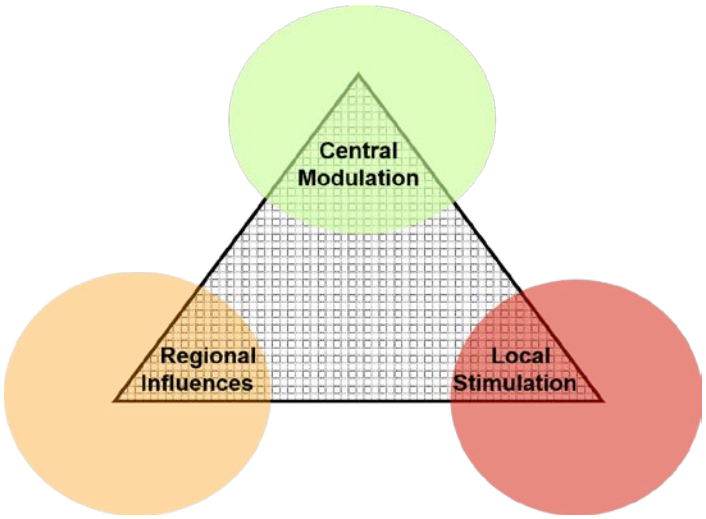


**Figure 6.1** Pain and Movement Reasoning Model

*Authors: Des O'Shaughnessy & Lester Jones*
*(licensed under a Creative Commons Attribution-NonCommercial 3.0 Unported License)*

## 6.2 Additional comment on methods

### 6.2.1 Recruitment and participants

The recruitment of physiotherapists from a range of clinical areas was important to address the research question. Recruitment at Site 1, for the quantitative component reported in Chapter 5, yielded a largely musculoskeletal sample with no participants identifying their Clinical Area as cardiorespiratory (see Table 6.1). Therefore, with the support of the local coordinator, the recruitment presentation at Site 2 emphasised the project was open to physiotherapists working in all clinical areas and we ensured that physiotherapists working in neurology and cardiorespiratory area were invited to participate.

All participants were invited to attend focus groups that were either pre-scheduled or at a negotiated time, or alternately were asked to arrange an interview with

the research assistant. The diversity of clinical areas represented in the sample was reflected in the subset of participants who joined the focus groups and interviews (see

**Table 6.1**

Type of Practice and Clinical Areas of participants across recruitment sites

| | Site 1 | Site 2 | Total |
|---|---|---|---|
| | N = 29 | N = 41 | N = 70 |
| | n (%)* | n (%)* | n (%)* |
| Main Type of Practice | | | |
| Hospital Inpatient | 4 (13.8) | 24 (58.5) | 28 (40) |
| Hospital Outpatient | 16 (55.2) | 10 (24.4) | 26 (37) |
| Community Health | 5 (17.2) | 3 (7.3) | 8 (11) |
| Rehabilitation Clinic | 2 (6.9) | 3 (7.3) | 5 (7) |
| Private Clinic | 2 (6.9) | 1 (2.4) | 3 (4) |
| Main Clinical Area | | | |
| Musculoskeletal | 17 (58.6) | 13 (31.7) | 30 (43) |
| Neurology/Neurosurgery | 4 (13.8) | 10 (24.4) | 14 (20) |
| Older People/Falls | 3 (10.3) | 6 (14.6) | 9 (13) |
| Cardiorespiratory | 0 (0.0) | 5 (12.2) | 5 (7) |
| Women's Health/Pelvic Floor | 2 (6.9) | 1 (2.4) | 3 (4) |
| General Medicine | 2 (6.9) | 1 (2.4) | 3 (4) |
| Orthopaedic | 1 (3.4 | 1 (2.4) | 2 (3) |
| Pain Management | 0 (0.0) | 2 | 2 (3) |
| Intensive Care | 0 | 1 | 1 (1) |
| Hand Therapy | 0 | 1 | 1 (1) |

*% do not add up to 100 due to rounding of decimal points

Table 6.2). While this subset was primarily self-selected, there were some individuals who were purposively invited because I felt they would offer a unique perspective. These included a participant who worked with adults with severe communication issues, a participant who was a clinical supervisor for postgraduate students, a participant working in pain management and a participant who had adapted the Model for use in patients

with continence problems. As a result of this, and the fortuitous self-selection by other participants, the diversity of the subset involved in this qualitative component of the research was similar to the whole sample.

**Table 6.2**

Type of Practice and Clinical Areas of participants: qualitative subset and total

| | Qualitative Subset | Whole Sample |
|---|---|---|
| | N = 29 | N = 70 |
| | n (%)* | n (%)* |
| Main Type of Practice | | |
| Hospital Inpatient | 9 (31) | 28 (40) |
| Hospital Outpatient | 14 (48) | 26 (37) |
| Community Health | 3 (10) | 8 (11) |
| Rehabilitation Clinic | 2 (7) | 5 (7) |
| Private Clinic | 1 (3) | 3 (4) |
| Main Clinical Area | | |
| Musculoskeletal | 11 (38) | 30 (43) |
| Neurology/Neurosurgery* | 6 (21) | 14 (20) |
| Older People/Falls* | 3 (10) | 9 (13) |
| Cardiorespiratory | 2 (7) | 5 (7) |
| Women's Health/Pelvic Floor | 3 (10) | 3 (4) |
| General Medicine | 1 (3) | 3 (4) |
| Orthopaedic | 1 (3) | 2 (3) |
| Pain Management | 1 (3) | 2 (3) |
| Intensive Care | 1 (3) | 1 (1) |

*% do not add up to 100 due to rounding of numbers

### 6.2.2 Qualitative analysis

The analysis was primarily deductive using two predetermined themes drawn from the research question: Suitability for Practice and Utility to Practice. While these are broad constructs, they guided the way I approached analysis of the participants' viewpoints. I was also open to other aspects emerging from the analysis, allowing interpretation of the data in a more inductive way (see codebook in Appendix F).

## 6.3 Contributions

| CRediT author statement | |
|---|---|
| Lester E Jones (65%) | • Conceptualisation<br>• Literature review<br>• Methodology<br>• Formal analysis<br>• Data curation<br>• Project administration<br>• Writing – original draft<br>• Writing – review and editing |
| Lisa H Amir (15%)<br>*(Primary supervisor 2017-2020)* | • Conceptualisation<br>• Methodology<br>• Formal analysis<br>• Project administration<br>• Writing – review and editing |
| Stephen Kent (10%)<br>*(Co-supervisor 2014-2020)* | • Conceptualisation<br>• Methodology<br>• Formal analysis<br>• Writing – review and editing |
| Hazel Heng (5%) | • Methodology<br>• Investigation<br>• Project administration<br>• Writing – review and editing |
| Sophie Heywood (5%) | • Methodology<br>• Investigation<br>• Project administration<br>• Writing – review and editing |

## 6.4 Submitted work *(redacted in this version)*

**Jones, L. E.**, Heng, H., Heywood, S., Kent, S., & Amir, L. H. (under review). The suitability and utility of the Pain and Movement Reasoning Model for physiotherapy: A qualitative study.

This paper was submitted to a journal on the 3rd May 2020 and returned with reviewers' comments and recommendations for revision on 27th August 2020. The revised manuscript has been resubmitted and at the time of writing is *under review*.

## 6.5 Related publications and presentations

A submitted book chapter in an edited textbook was developed alongside the research activity reported here and in Chapter 5. I was invited to contribute a chapter on pain mechanisms to this two-volume publication on sports injuries and recruited the co-creator of the Pain and Movement Reasoning Model, Des O'Shaughnessy, to take the lead on development and writing. The chapter is titled, *Making sense of pain in sports physiotherapy: Applying the Pain and Movement Reasoning Model* (O'Shaughnessy & Jones, 2020) and presents the application of the Model in a sporting context.

In this book chapter, we adapted the descriptors within the categories of the Model to emphasise aspects of sports physiotherapy context. I encouraged participants in the doctoral research project to similarly adapt the Model for their clinical context. In the face-to-face sessions of the education intervention, I explained that because clinical reasoning is based on individual knowledge and experiences, some of the terminology and subcategories in the original version of the Model may need to be changed to better align with individual ways of thinking and practicing. One participant took the opportunity to explore adopting the Model in her continence work, but no one else reported adapting the Model. Outside of this doctoral research project there are examples of adaptations of the Model and these are presented in Chapter 7.

## 6.6 Concluding comments

The participants in this study reported the Pain and Movement Reasoning Model aligned with existing ways of working, especially for those have adopted a biopsychosocial framework in their clinical practice. Use of the Model was reportedly beneficial for the physiotherapists' pain reasoning, the management of the patients' pain conditions, and also in education. These findings are encouraging because of the

diverse clinical areas that participants represented suggesting that the Model can be applied more widely than the musculoskeletal outpatient context it was designed for.

## 6.7 References

**Jones, L. E.**, Heng, H., Heywood, S., Kent, S., & Amir, L. H. (submitted). The suitability and utility of the Pain and Movement Reasoning Model for physiotherapy: A qualitative study.

O'Shaughnessy, D. F. P., & **Jones, L. E.** (2020). Making sense of pain in sports physiotherapy: Applying the Pain and Movement Reasoning Model. In S. B. Porter & J. Wilson (Eds.), *A Comprehensive Guide to Sports Physiology and Injury Management,* Elsevier.

# Chapter 7 – Beyond physiotherapy

## 7.1 Introduction

One of the benefits of postgraduate study at the Judith Lumley Centre was the opportunity to explore ideas amongst the diverse group of academics and Research Higher Degree students. The research group were largely midwives exploring issues related to pregnancy, childbirth and early motherhood, but there was also a strong social research program investigating issues such as intimate partner violence (Judith Lumley Centre, 2020). Professor Lisa Amir, a General Practitioner, International Board Certified Lactation Consultant since 1989, and international breastfeeding researcher was an a senior member of the team at the Centre. She was supervising Miranda Buck, neonatal nurse and International Board Certified Lactation Consultant, for her PhD project, *Nipple pain in early motherhood*, and the three of us adapted the Pain and Movement Reasoning Model to the Breastfeeding Pain Reasoning Model (Amir, Jones, & Buck, 2015). We changed one category from *Regional Influences* to *External Influences* as nipple and breast pain could be related to external factors such as infant attachment to the breast and use of breast pumps. We also revised the subcategories and descriptors to suit the context. In the published paper, we presented the prevalence and the impact of pain with breastfeeding and argued the need for a more sophisticated assessment of pain in breastfeeding women. This included some examples of how the Breastfeeding Pain Reasoning Model could be applied and how it enables the consideration of a wider variety of management techniques by the practitioner. Importantly this is an example of how the Pain and Movement Reasoning Model can be adapted to contexts, not specific to physiotherapy.

## 7.2 Contributions

| CRediT author statement | |
|---|---|
| Lisa Amir (40%)<br>*(Primary Supervisor 2017-2020)* | • Conceptualisation<br>• Literature review<br>• Writing – original draft<br>• Writing – review and editing |
| Lester Jones (40%) | • Conceptualisation<br>• Literature review<br>• Writing – original draft<br>• Writing – review and editing |
| Miranda Buck (20%) | • Conceptualisation<br>• Literature review<br>• Writing – original draft<br>• Writing – review and editing |

## 7.3 Published work

Amir, L. H., **Jones, L. E.**, & Buck, M. L. (2015). Nipple pain associated with breastfeeding: incorporating current neurophysiology into clinical reasoning. *Australian Family Physician, 44*(3), 127-132.

Permission statement

> Reproduced with permission from The Royal Australian College of General Practitioners from: Amir, L.H., Jones, L.E., Buck, M.L. Nipple pain associated with breastfeeding: Incorporating current neurophysiology into clinical reasoning. Aust Fam Physician 2015;44(3):127–32. Available at www.racgp.org.au/afp/2015/march/nipple-pain-associated-with-breastfeeding-incorporating-current-neurophysiology-into-clinical-reasoning/

# Nipple pain associated with breastfeeding: incorporating current neurophysiology into clinical reasoning

**Lisa H Amir**, Lester E Jones, Miranda L Buck


## Background

New mothers frequently experience breastfeeding problems, in particular nipple pain. This is often attributed to compression, skin damage, infection or dermatitis.

## Objective

To outline an integrated approach to breastfeeding pain assessment that seeks to enhance current practice.

## Discussion

Our clinical reasoning model resolves the complexity of pain into three categories: local stimulation, external influences and central modulation. Tissue pathology, damage or inflammation leads to local stimulation of nociceptors. External influences such as creams and breast pumps, as well as factors related to the mother, the infant and the maternal–infant interaction, may exacerbate the pain. Central nervous system modulation includes the enhancement of nociceptive transmission at the spinal cord and modification of the descending inhibitory influences. A broad range of factors can modulate pain through central mechanisms including maternal illness, exhaustion, lack of support, anxiety, depression or history of abuse. General practitioners (GPs) can use this model to explain nipple pain in complex settings, thus increasing management options for women.



## Keywords

pain; women's health; obstetrics/pregnancy; breastfeeding


New mothers frequently experience breastfeeding problems and many seek support.[1,2] In the first year, mothers and infants make an average of 36 visits to healthcare providers, eight of those to their general practitioner (GP).[3] Healthcare providers approached by new mothers must be able to adequately assess breastfeeding problems and provide solutions. Women find it unhelpful when health professionals suggest they stop breastfeeding. Incorrect advice is a major cause of premature cessation of breastfeeding.[4-6]

Challenges to breastfeeding are common and persistent; our recent study of 340 primiparous women in Melbourne found that 79% experienced nipple pain and 58% nipple damage.[7] Although many women continue to breastfeed despite experiencing considerable pain, nipple pain is the second most common reason given for women ceasing to breastfeed before they had planned to do so, the first being perceived low supply.[8]

Nipple pain is generally attributed to mechanical stressors, physiological responses and infection.[9] Poor latch is the most common cause of damage to nipples.[9] Any nipple distortion or bruising of the skin is indicative of a significant mechanical problem. About 50% of breastfeeding women complain of damage to their nipples, which increases the risk of skin infections and mastitis.[9] The assumption is that damage to nipple tissue causes pain and that pain is an indicator of tissue damage. Considering the extensive literature on pain and neuroplasticity, including central reorganisation, the relationship between tissue pathology and pain is more sophisticated than this.[10] In contrast to vulval pain, where the possible interacting roles of candidiasis, dermatitis and allodynia are acknowledged,[11] we believe the understanding of nipple pain in lactation has been overly simplistic.

To enhance current practice, we have proposed an integrated approach to the assessment of breastfeeding pain. Incorporating current concepts from neuroscience relating to neuroplasticity[12] and pain,[13] we use a biopsychosocial lens to

review possible determinants of the nipple pain experience. We adapted a template originally designed to assist clinical reasoning for musculoskeletal pain,[14] to help the clinician to recognise the potential contributors to women's nipple pain, and to categorise these in terms of pain mechanisms. This enables the identification of treatment targets on the basis of the predominant contributors. We provide brief case studies to illustrate the increased management options that become available when a comprehensive range of contributors is considered.

## The template

The template refers to the 'Pain and Movement Reasoning Model', a reasoning tool developed to incorporate the range of influences and determinants of pain identified in current literature.[14] This model is represented by a gridded triangle. The apices refer to three categories: 'local stimulation', 'regional influences' and 'central modulation'. These categories are interdependent (eg regional influences may lead to local stimulation mechanisms). After considering the clinical information relevant to the three categories, the clinician marks a point on the grid to best represent clinical judgement of the relative contribution of each. This ensures the consideration of the range of potential contributors to pain and results in holistic interpretation of a person's pain report. This clinical reasoning tool therefore enables the clinician to consider the multiple dimensions of pain in the decision-making process.

We have modified the Pain and Movement Reasoning Model template to address nipple pain. Our version is called the Breastfeeding Pain Reasoning Model (*Figure 1*). The category headings were slightly modified to best represent the breastfeeding context: local stimulation, external influences and central modulation. These categories are described below.

## Local stimulation

In the Breastfeeding Pain Reasoning Model, 'local stimulation' refers to mechanical stimuli, such as nipple compression, but also encompasses inflammatory and infective states that contribute to nociception. Mechanonociceptors respond to strong mechanical stimuli that cause distortion of the nipple tissue. Where these stimuli are of sufficient strength and frequency to cause breakdown of the skin, cytokines, such as gamma-interferon, interleukins 1 and 6, and tumour necrosis factor are released.[13,15] As a result, chemonociceptors are activated and the inflammatory response is initiated with contribution from afferent antidromic release of substance P and calcitonin gene related peptide (CGRP), which are both vasodilators.[15] The inflammatory exudate has been labelled a 'sensitising soup' and contains substances that have the ability to further activate and sensitise nociceptors – peripheral sensitisation.[16] These substances include noradrenaline, bradykinin, histamine, prostaglandins, serotonin, nerve growth factor and cytokines.[15,16] Nociceptors in cracked and damaged nipple tissue will become sensitised, leading to activation of mechanical nociceptors and other afferents at reduced thresholds. Damaged nipple skin is likely to be colonised with bacteria (eg *Staphylococcus aureus*) and/or fungi (eg *Candida albicans*).[9] Recent evidence suggests that pathogenic bacteria not only trigger an inflammatory response, but can activate nociceptors directly.[17] Importantly, the neural transmission from an activated nociceptor is not pain, but deactivating the nociceptor or removing the threatening stimulus may reduce or relieve pain. This would especially be the case in less complex presentations, where central nervous system (CNS) factors have only a small role in the woman's pain experience.

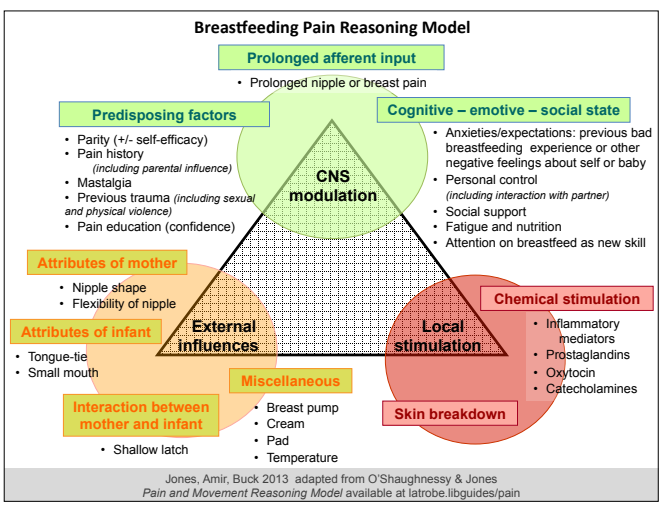


**Figure 1**. Pain reasoning model – nipple and breast pain
*(Available under licence CC BY-NC Aus 3.0 at http://latrobe.libguides.com/content.php?pid¼109542&sid=825367)*

## External influences

The external influencing category includes factors that might contribute to the woman's nipple pain experience but are not due to a pathological process. That is, they are not likely to provoke an inflammatory response but may predispose, exacerbate or contribute to the process. In the context of nipple pain, we have divided this category into four subcategories: attributes of the mother, attributes of the infant, the interaction between mother and infant, and finally of miscellaneous other external influences (eg breast pump).

Attributes of the mother that might contribute to the woman's experience of nipple pain include the shape of nipple and its adaptability to any distortion. During breastfeeding, the nipple needs to be sufficiently elastic to be positioned deep in the infant's mouth, which may not be possible for some women with flat or very short or wide nipples.[18]

Attributes of the baby contributing to maternal pain include anatomy of the mouth, such as size and shape of mouth, palate and tongue. Babies with very small mouths, receding chins, high palate or restricted tongue movements may be hard to latch without maternal pain. Restriction of tongue movement may be obvious in some infants with classic tongue-ties (ankyloglossia),[19] but less obvious restriction occurs in some infants with posterior tongue-ties.[20]

The third subcategory relates to the interaction between infant's mouth and mother's nipple and breast. When the infant is well positioned on the breast, the nipple is deep in the baby's mouth and movement of the tongue and jaw is felt as a drawing sensation by the mother. In this situation, the nipple is not distorted after the feed and the nipple skin is undamaged. Poor attachment or latching can lead to visible compression of the nipple after the feed, and may lead to skin breakdown.[21]

The last subcategory refers to other external contacts with the nipple: topical products (eg soap and creams), products such as pads (breast pads for absorbing milk leakage, or hydrogel or other dressings) and breast pumps. Some products used on the nipple and areola may cause an irritant or allergic dermatitis.[22] An important external agent is the breast pump, which most new mothers are using.[23] Breast pumps can cause nipple damage if the flange is too tight, the suction too high or the pump used for too long.[24]

## Central modulation

Input from the peripheral nervous system can be amplified or inhibited via CNS processes. Amplification of neural activity or loss of normal inhibition can result in a sensitised state. There is a vast array of factors that alter CNS sensitivity. First, a prolonged inundation of impulses through sensory fibres can enhance neural transmission at the spinal cord.[10] Changes that can occur at the dorsal horn of the spinal cord include increased neurotransmitter production presynaptically and the production or relocation of more receptors postsynaptically. Neuroplastic alterations to receptors also make them more easily activated, increasing the transmission to

**Table 1. Management options using the breastfeeding pain reasoning model**

| Categories | Examples of management strategies |
|---|---|
| **Local stimulation** | Improve healing:<br>• wash nipple regularly<br>• use antibacterial pads or hydrogel dressings<br>• apply purified lanolin before and after feeding/expressing<br>Localised infection:<br>• apply topical antibiotic ointment (eg mupirocin 3 x/day after feeds) or antifungal (eg miconazole oral gel 4 x/day after feeds)<br>Local inflammation:<br>• apply topical steroid (eg mometasone ointment once/day after feeds) |
| **External influences** | Improve attachment of baby to breast[33]<br>Reduce sources of nipple trauma:<br>• release infant tongue-tie (if present)<br>• user lower setting on breast pump<br>• hire more effective breast pump<br>Reduce friction from breast pump:<br>• apply lubricant (sunflower oil, lanolin) prior to expressing<br>• ensure correct size flange is being used<br>Trial of nipple shield<br>Remove sources of irritation:<br>• creams/gels<br>• avoid soap, chlorine swimming pools, other irritants<br>Temporarily reduce duration/frequency of feeds/expressing (supplementation with infant formula may be required if milk supply not sufficient)* |
| **Central modulation** | Manage pain elsewhere (*Table 2*):<br>• analgesia<br>• massage[34]<br>Improve maternal rest and sleep:<br>• arrange child care or reduce mother's home duties<br>Maximise comfortable positions for feeding:<br>• try laid-back feeding or reclining as on a deck chair rather than sitting upright or hunching forward<br>If cold is a factor:<br>• avoid airing nipples<br>• keep nipples warm<br>• apply heat pack<br>• try magnesium supplement<br>• consider nifedipine (commence with 20 mg sustained release daily and increase PRN)[33]<br>Refer for psychological support (*Table 2*)<br>Refer to peer support (*Table 2*)<br>• ABA, PANDA, new mothers'group or online parenting groups |

**This option is not ideal but may appeal to mothers who are considering stopping breastfeeding completely*

**Table 2. Referral options**

| Categories | Examples |
|---|---|
| **Breastfeeding support** | International Board Certified Lactation Consultant*<br>Hospital breastfeeding service<br>Community breastfeeding clinic<br>Australian Breastfeeding Association (ABA)† |
| **Psychological support** | Clinical psychologist<br>General practitioner<br>Psychiatrist<br>Relationship counselling<br>Post and Antenatal Support Association (PANDA)‡<br>Family/mother–baby units |
| **Physical support** | Physiotherapist<br>Massage therapist<br>Osteopath<br>Occupational therapist |
| **Medical specialist** | Dermatologist<br>Musculoskeletal specialist |
| **Pain management** | Acupuncture<br>Hypnotherapy<br>Pain clinic |

**Lactation Consultants of Australia and New Zealand, www.lcanz.org/find-a-consultant.htm*
*†www.breastfeeding.asn.au/*
*‡www.panda.org.au/*

second-order neurons and higher centres. In practice, this may translate to the woman having an increased pain response to tissue deformation in the affected breast.

Genetic predisposition and expression of phenotypes related to pain sensitivity also need to be considered and perhaps explains the comorbidity of some pain conditions.[25] Glial cells and the immune system have been identified as having a major influence on pain.[26] Arguably, pain is just the most overt sign of the body's protection system. Therefore a woman who is unwell, particularly with infective or inflammatory conditions, may be predisposed to be more sensitive to other noxious stimuli.

Importantly, factors that reduce the inhibition initiated by higher centres can also cause more excitation in these second-order neurons.[13] This disinhibition leads to a state of increased sensitivity and is influenced by factors such as fatigue, lack of social support, sense of failure, beliefs about the risk of harm, anxiety and low mood. Notably, sleep deprivation increases sensitivity to pain (hyperalgesia), especially hyperalgesia to cold,[27] so it is not surprising that new mothers who experience weeks or months of interrupted sleep may complain of increased sensitivity to cold environments. Nipple pain associated with nipple vasospasm has been reported anecdotally in women predisposed to poor circulation or Raynaud's phenomenon.[9] Social distress associated with loneliness or feelings of rejection is linked to higher pro-inflammatory activity and sensitivity to pain.[28] Holding the hand of a loved one can reduce measurable pain-related neural activity as well as self-reported pain.[28]

## Management options

The Breastfeeding Pain Reasoning Model gives us a structure to consider categories of management: local, external and central. *Table 1* provides examples of management options. Local stimulation can be reduced by treatments that improve healing, such as purified lanolin, or application of topical antibiotics or corticosteroids, as appropriate. Reducing external stimulation can include improving attachment of the infant to the breast, or improving the use of the breast pump (ensuring flange is not too tight, using lubricant – lanolin or sunflower oil – before pumping), avoiding excessive time of either baby or pump on the breast, removing/reducing irritants – creams, breast pads – avoiding cold, applying hot packs or 'breast warmers'. Other strategies, such as the use of a nipple shield or dummy, or expressing and bottle/cup feeding to reduce duration of nipple trauma, may be appropriate. Central modulation can be managed by strategies such as increasing maternal rest, massage for the upper thoracic/neck region, and social support, as well as centrally acting medications that alter nerve function. Understandably, some women who experience nipple pain think the worst of the situation, with magnification of pain symptoms, rumination and feelings of helplessness and pessimism.[29] Psychological techniques such as distraction, cognitive reframing, relaxation and fostering effective coping strategies may be beneficial.[30]

## Application of the Breastfeeding Pain Reasoning Model

Keeping the Breastfeeding Pain Reasoning Model in mind, the clinician can consider the various inputs into the mother's pain experience and the relative importance of local, external and central factors (*Figure 1*). The clinician can plot their assessment of the pain experience onto the grid, or just keep it in mind, as they move on to explain the situation to the patient and recommend treatment options.

The first case study is a straightforward situation of a mother at day 5 postpartum, who has experienced superficial skin damage due to poor positioning of her infant on the breast initially, but now has

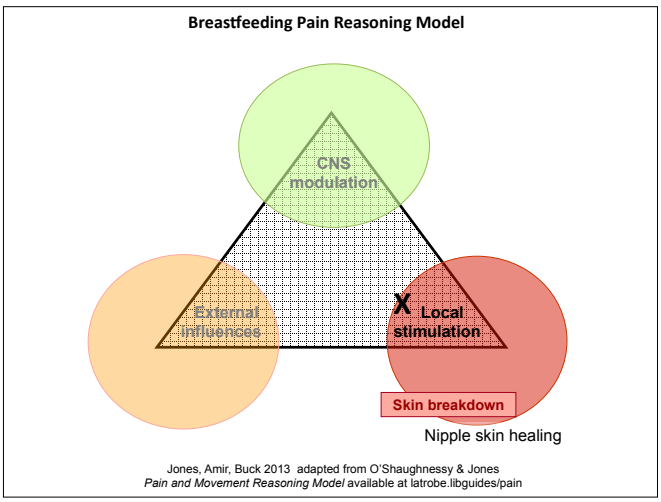


**Figure 2**. Pain reasoning model – Case 1 – nipple pain

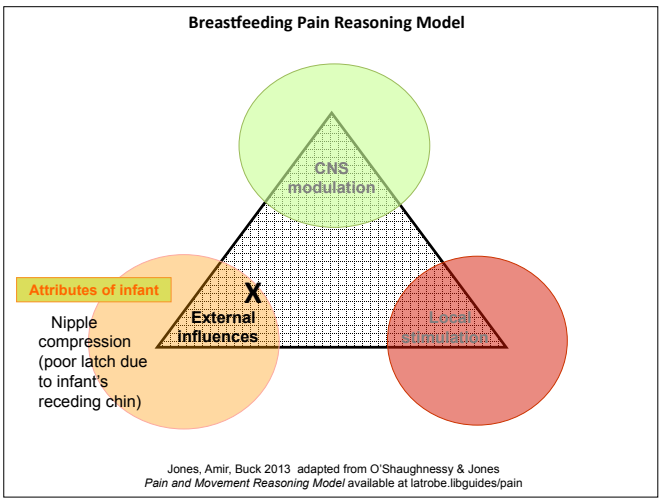


**Figure 3**. Pain reasoning model – Case 2 – nipple pain

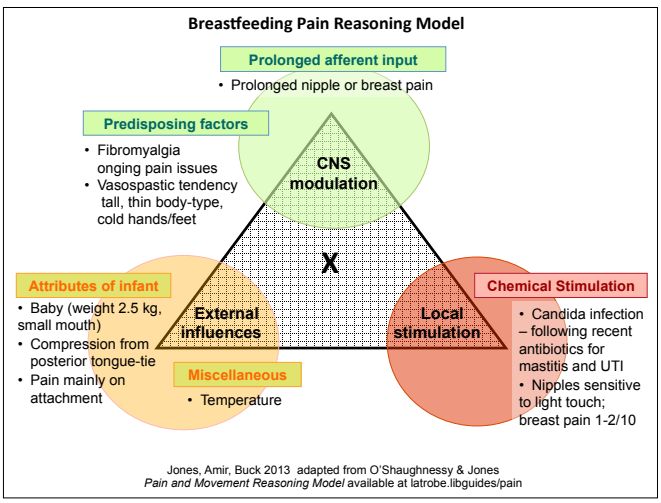


**Figure 4**. Pain reasoning model – Case 3 – nipple and breast pain

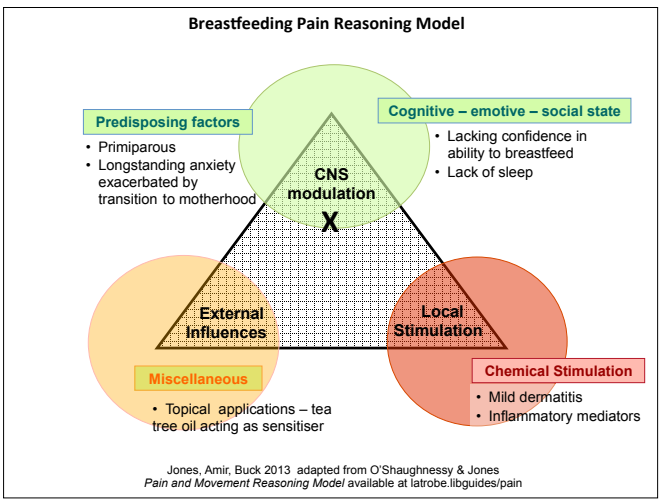


**Figure 5**. Pain reasoning model – Case 4 – nipple and breast pain

nipple skin healing and minimal pain (local factors: *Figure 2*). A scenario where the nipple pain occurs solely when feeding the baby directly at the breast, with no pain when expressing or between feeds, can be seen in *Figure 3* (external factors). It could be argued that there is less need for the Model in these simpler presentations; however, it is important that the clinician is alert to factors that may lead to persistent nipple pain and addresses them early.

The usefulness of the model is more apparent when women present with ongoing nipple pain. Case 3 is a more complicated scenario: the mother has a history of fibromyalgia and, in the past, had recurrent vaginal thrush following antibiotics (*Figure 4*). Her baby weighed 2.5 kg at birth and had a small mouth, causing some mechanical damage to her nipples. The mother required antibiotics for the first 2 weeks postpartum for a urinary tract infection and for mastitis. At 4 weeks postpartum, she had burning, sensitive nipples and some radiating breast pain. On the commonly used pain score, where 0 equals no pain and 10 is the worst pain possible, she reported the nipple sensitivity of 1–2 out of 10. In this scenario, the clinician can explain to the mother that there are a number of factors contributing to her pain: local infection (nipple/breast candidiasis is causing the low level nipple sensitivity), external trauma (baby's small mouth is causing the pain on attachment) and central modulation (caused by her co-existing chronic pain condition). By acknowledging the contributing factors, the focus is not

reliant on multiple courses of antifungals to achieve pain-free breastfeeding, and other options can also be suggested (*Table 1*). Using pain scores helps us to estimate the input of each of these pain sources.

The last scenario, shown in *Figure 5*, is of a woman with a long history of anxiety (Case 4). Her anxiety about nipple sensitivity led her to apply tea tree oil as an antifungal treatment/preventive measure. However, tea tree oil is a common skin irritant[31] and caused a mild dermatitis. Considering each apex of the triangle provides opportunities for a range of management and referral options. *Table 2* provides the GP with a wide range of possible sources of support for the patient with ongoing breastfeeding pain.

## Conclusion

When the clinician understands the meaning of nipple pain to the woman, and makes use of the range of management options available, there is rarely a need to suggest ceasing breastfeeding, unless that is the mother's decision.[31] By using this Breastfeeding Pain Reasoning Model, clinicians can identify the predominant influences on nipple pain. This enables them to provide realistic advice to women and ensure systems are in place to provide effective support for breastfeeding from appropriate health professionals and community resources (*Table 2*).[32]

## Key points

- Nipple pain is a common problem for breastfeeding women. Ongoing pain may be multifactorial.
- Our model considers local, external and central factors that contribute to the new mother's pain experience.
- GPs can use this model to explain the situation to the patient and increase the range of potential management strategies.

### Authors

Lisa H Amir MBBS, MMed, PhD, IBCLC, FABM, FILCA, Principal Research Fellow, Judith Lumley Centre, La Trobe University, Melbourne, VIC. l.amir@latrobe.edu.au

Lester E Jones MScMed (PM), PhD candidate, Judith Lumley Centre, La Trobe University, Melbourne, VIC

Miranda L Buck RN, BA, MPhil, IBCLC, PhD candidate, Judith Lumley Centre, La Trobe University, Melbourne, VIC

Competing interests: None.

Provenance and peer review: Not commissioned, externally peer reviewed.

### Acknowledgments

Des O'Shaughnessy (co-author Pain and Movement Reasoning Model) provided the initial framework to enable the comprehensive consideration of neurophysiology of pain for this article.

### References

1. Sword W, Watt S. Learning needs of postpartum women: does socioeconomic status matter? Birth 2005;32:86–92.
2. Forster DA, McLachlan HL, Rayner J, Yelland J, Gold L, Rayner S. The early postnatal period: exploring women's views, expectations and experiences of care using focus groups in Victoria, Australia. BMC Pregnancy Childbirth 2008;8:27.
3. McCallum S, Rowe H, Gurrin L, Quinlivan J, Rosenthal D, Fisher J. Unsettled infant behaviour and health service use: a cross-sectional community survey in Melbourne, Australia. J Paediatr Child Health 2011;47:818–23.
4. Attard Montalto S, Borg H, Buttigieg-Said M, Clemmer EJ. Incorrect advice: the most significant negative determinant on breast feeding in Malta. Midwifery 2010;26:e6–13.
5. Hauck YL, Graham-Smith C, McInerney J, Kay S. Western Australian women's perceptions of conflicting advice around breast feeding. Midwifery 2011;27:e156–62.
6. Brodribb W, Zadoroznyj M, Dane A. The views of mothers and GPs about postpartum care in Australian general practice. BMC Fam Pract 2013;14:139.
7. Buck ML, Amir LH, Cullinane M, Donath SM, CASTLE study team. Nipple pain, damage and vasospasm in the first eight weeks postpartum. Breastfeed Med 2014;9:56–62.
8. Odom EC, Li R, Scanlon KS, Perrine CG, Grummer-Strawn L. Reasons for earlier than desired cessation of breastfeeding. Pediatrics 2013;131:e726–32.
9. Eglash A, Montgomery A, Wood J. Breastfeeding. 2008;54:343–411.
10. Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. Pain 2011;152:S2–15.
11. Nunns D, Murphy R. Assessment and management of vulval pain. BMJ 2012;344:e1723.
12. Butz M, Worgotter F, van Ooyen A. Activity-dependent structural plasticity. Brain Res Rev 2009;60:287–305.
13. Melzack R, Katz J. Pain. WIREs Cogn Sci 2013;4:1–15.
14. Jones LE, O'Shaughnessy DFP. The pain and movement reasoning model: introduction to a simple tool for integrated pain assessment. ManTher 2014;19:270–76.
15. Gold MS, Gebhart GF. Nociceptor sensitization in pain pathogenesis. Nat Med 2010;16:1248–57.
16. Woolf CJ, Chong MS. Preemptive analgesia–treating postoperative pain by preventing the establishment of central sensitization. Anesth Analg 1993;77:362–79.
17. Chiu IM, Heesters BA, Ghasemlou N, et al. Bacteria activate sensory neurons that modulate pain and inflammation. Nature 2013;501:52–57.
18. Sakalidis VS, Williams TM, Garbin CP, et al. Ultrasound imaging of infant sucking dynamics during the establishment of lactation. J Hum Lact 2013;29:205–13.
19. Kumar M, Kalke E. Tongue-tie, breastfeeding difficulties and the role of frenotomy. Acta Paediatr 2012;101:687–89.
20. Hong P, Lago D, Seargeant J, Pellman L, Magit AE, Pransky SM. Defining ankyloglossia: A case series of anterior and posterior tongue ties. Int J Pediatr Otorhinolaryngol 2010;74:1003–06.
21. Ziemer MM, Pigeon JG. Skin changes and pain in the nipple during the 1st week of lactation. J Obstet Gynecol Neonatal Nurs 1993;22:247–56.
22. Amir LH. Eczema of the nipple and breast: a case report. J Hum Lact 1993;9:173–75.
23. Johns HM, Forster DA, Amir LH, Moorhead AM, McEgan KM, McLachlan HL. Infant feeding practices in the first 24-48 h of life in healthy term infants. Acta Paediatr 2013;102:e315–20.
24. Clemons SN, Amir LH. Breastfeeding women's experience of expressing: a descriptive study. J Hum Lact 2010;26:258–65.
25. Diatchenko L, Nackley AG, Tchivileva IE, Shabalina SA, Maixner W. Genetic architecture of human pain perception. Trends Genet 2007;23:605–13.
26. Watkins LR, Maier SF. Targeting glia to control clinical pain: an idea whose time has come. Drug Discovery Today: Therapeutic Strategies 2004;1:83–88.
27. Schuh-Hofer S, Wodarski R, Pfau DB, et al. One night of total sleep deprivation promotes a state of generalized hyperalgesia: A surrogate pain model to study the relationship of insomnia and pain. Pain 2013;154:1613–21.
28. Eisenberger NI. The pain of social disconnection: examining the shared neural underpinnings of physical and social pain. Nat Rev Neurosci 2012;13:421–34.
29. Watkins S, Meltzer-Brody S, Zolnoun D, Stuebe A. Early breastfeeding experiences and postpartum depression. Obstet Gynecol 2011;118:214–21.
30. Linton SJ, Shaw WS. Impact of psychological factors in the experience of pain. Phys Ther 2011;91:700–11.
31. Christoffers WA, Blomeke B, Coenraads PJ, Schuttelaar M-LA. Co-sensitization to ascaridole and tea trea oil. Contact Dermatitis 2013;69:187–89.
32. Hegney D, Fallon T, O'Brien ML. Against all odds: a retrospective case-controlled study of women who experienced extraordinary breastfeeding problems. J Clin Nurs 2008;17:1182–92.
33. Amir LH. Managing common breastfeeding problems in the community. BMJ 2014;348:g2954. Available at www.bmj.com/content/348/bmj.g2954.long [Accessed 12 December 2014].
34. Kernerman E, Park E. Severe breast pain resolved with pectoral muscle massage. J Hum Lact 2014;30:287–91.

## 7.4 Related publications and presentations

The Breastfeeding Pain Reasoning Model is one of three adapted Models that have been created for contexts not specific to physiotherapy. The other two – for survivors of torture and women with pelvic pain –have been developed by relevant experts and presented to multi-disciplinary audiences.

### 7.4.1 Pain in survivors of torture

A physiotherapist, Melanie Block, and her refugee health team at CoHealth (Community health service in Melbourne), and Dr. David Kelly, University of Melbourne, helped to develop a version of the Model for use with survivors of torture and trauma. This was used in training health and social care professionals at CoHealth and at Foundation House (Victorian Foundation for the Survivors of Torture) and presented at the inaugural International Conference on Migration, Social Disadvantage and Health (Jones & Block, 2015). The most recent presentation of this version of the Model was for a webinar for the International Association for the Study of Pain Global Year Against Pain in the Most Vulnerable (Jones, 2019). I also have included it in a book chapter I was invited to contribute to (Amris, Jones, & Williams, in press) in *Research Handbook on Torture*, edited by Jens Modvig, chairperson of the UN Committee Against Torture, and Sir Malcolm Evans, chairperson of the Subcommittee on Prevention of Torture. This is expected to be published in late 2020.

### 7.4.2 Pelvic pain in women

I developed the Pelvic Pain Reasoning Model for Women with Dr Margaret Sherburn who was head of the Physiotherapy Department at The Women's Hospital in Melbourne and Rachael Sheat a physiotherapist working in private practice with a special interest in pain and women's health. This version of the Model was first

presented as part of a workshop at a joint national meeting of the Continence Foundation of Australia, International Children's Continence Society and the Uro-gynaecological Society of Australasia (Sherburn, Jones, & Sheat, 2014). While this version of the Model has not been published in peer-reviewed literature, it has been well received and subsequently incorporated into a range of presentations by myself and colleagues. These include presentations at two Pelvic Pain Victoria events. The first was at a lecture evening with a multidisciplinary audience in April 2016. I co-presented with Anne-Florence Plante, *Pelvic Pain Reasoning Model for Women: Capturing the complexity*. The second was a workshop at a two-day seminar in October 2017, primarily involving physiotherapists, where participants were able to apply the Model to different cases. This group seemed to be particularly engaged with contemporary pain science and the Model was considered a helpful addition to their way of thinking and practicing.

### 7.4.3 Professional development for medical professionals

I have also introduced the original Model to Australian doctors. At the Royal Australian College of General Practitioners national conference in 2015, I delivered a presentation with Dr. Debra Wilson, a local doctor working on developing a back pain management pathway. During our discussions it was apparent the Model could be a useful tool to General Practitioners working in busy medical clinics. I presented the Model to General Practitioners as my contribution to an Active Learning Module developed by a multidisciplinary group and titled Time Efficient Management of Pain in the Office (TEMPO) (Holliday et al., 2020). The original model was also introduced to trainee psychiatrists at the University of Melbourne including a recorded presentation for blended learning delivery of persistent pain topics.

## 7.5 Concluding comments

The Pain and Movement Reasoning Model was designed for musculoskeletal physiotherapy outpatient settings. In the previous Chapter we saw how it can be adapted beyond this context by physiotherapists working in a range of different clinical areas. In this Chapter, we have extended that idea further, by demonstrating that in collaboration with experts in other fields, the Model can be easily adapted for contexts beyond physiotherapy practice. Further research on the suitability and utility in disciplines other than physiotherapy is required.

## 7.6 References


Amir, L. H., **Jones, L. E.**, & Buck, M. L. (2015). Nipple pain associated with breastfeeding: incorporating current neurophysiology into clinical reasoning. *Australian Family Physician, 44*(3), 127-132.

Amris, K., **Jones, L. E.**, & Williams, A. C. d. C. (in press). Treating pain after torture. In J. Modvig & M. Evans (Eds.), *Research Handbook on Torture*: Edward Elgar Publishing.

Holliday, S., Hayes, C., **Jones, L. E.**, Gordon, J., Fraser, C., Harris, N., . . . Magin, P. (2020). Prescribers or multidisciplinarians: An evaluation of brief education for General Practitioners on chronic pain management. *Health Education in Practice, 3(1). http://dx.doi.org/10.33966/hepj.3.1.14146.*

**Jones, L. E.** (2019). Pain management in survivors of torture: A physiotherapist's perspective. *Global Year Against Pain in the Most Vulnerable.* Retrieved from https://youtu.be/nNQ4uvKOgWo

**Jones, L. E.**, & Block, M. (2015). Pain and Movement Reasoning Model: A tool for educating health and social care professionals about the multiple influences and determinants of pain in survivors of torture and trauma . Paper presented at the International Conference on Migration, Social Disadvantage and Health, Melbourne, Australia.

Judith Lumley Centre. (2020). Our research programs. Retrieved from https://www.latrobe.edu.au/jlc/research

Sherburn, M., **Jones, L. E.**, & Sheat, R. (2014). *Pelvic pain: developing a tool to enhance education and assist clinical reasoning*. Paper presented at the 23rd National Conference on Incontinence, Cairns, Australia.

# Chapter 8 – Discussion

For the first time, the Pain and Movement Reasoning Model has been formally evaluated. The aims and scope of this thesis were to determine the utility of the Model, including its suitability for different clinical areas and the impact on the pain literacy of physiotherapists. Chapters 2 and 3 provided a thorough exploration of the neuro-immune-endocrine factors, as well as cognitive-related and emotion-related factors, that influence the human pain experience. This detailed overview reinforced the initial conceptual basis of the Model, in particular the integrated biopsychosocial approach to clinical reasoning. The doctoral research project was a mixed method study, which identified the potential of a brief workplace education intervention to improve pain literacy, and confirmed the suitability of the Model for physiotherapy practice. It also allowed the recording of examples of how physiotherapists applied the Model in their work (as described in Chapters 4, 5 and 6). Finally, Chapter 7 explored the application of the Model beyond physiotherapy, incorporating expert advice in the development of variations of the Model for other, selected clinical areas or client groups.

I start this chapter by considering some developments that have occurred across the period of my candidature and link these to the findings of the empirical research. I will then discuss practical and theoretical implications of the thesis and examine the strengths and limitations of this work. I finish the chapter by describing how the thesis contributes to broader knowledge, as well as suggesting ideas for future research .

## 8.1 Changing contexts: pain concepts and Australian physiotherapy

One of the issues with undertaking a part-time PhD candidature is that the context for the area of study can change substantially between the start and finish of the research training. This is something I want to briefly address in this section.

### 8.1.1 Evolving concepts of pain

In Chapter 2, I introduced a key paper that focused my thinking on the direction of this thesis. In that review paper, Fabrizo Benedetti (2013) brought together the evidence relating to neuro-immune-endocrine interactions that occur between doctors and patients during clinical consultations. Related concepts are presented in Franziska Denk's work on pain vulnerability, with an emphasis on the combined influence of genetic factors and life experience on pain (Denk & McMahon, 2012; Denk, McMahon, & Tracey, 2014). These publications reinforced my long-held belief, that it was unhelpful to consider pain as simply *acute* or *chronic,* by providing evidence that pain is influenced by past experiences and changes in neuro-immune-endocrine expression.

The long term sensitivity changes highlighted in Denk's work (2014), along with a focus on pain as part of an organism's protective response, have subsequently been explored in a series of articles toward an evolutionary conceptualisation of pain (Nesse & Schulkin, 2019; Walters & Williams, 2019). In these review papers, there are some interesting ideas presented on the benefits of increased sensitivity (Nesse & Schulkin, 2019; Walters & Williams, 2019) and the potential negative effect of interrupting normal feedback systems, through the use of analgesics (Nesse & Schulkin, 2019). These ideas, that align with my explanation of amplified pain, or persistent pain, as an

*overapplied protective response*, could be drawn into future research as part of the education supporting the application of the Model.

A central theme of the thesis is that pain is biopsychosocial in nature. My interpretation of *biopsychosocial* is that the components are integrated and impossible to unpack into its discrete components – especially in any sort of measurable way. For example, a feature of the social environment may lead to distress and mood shift, which then affects movement and posture and the sensitivity of nociception – and then they all feedback on each other (Jones & O'Shaughnessy, 2014). It is because of this multidirectional feedback that we cannot pull this apart to explore a discrete social component, a discrete psychological component or a discrete biological component. The understanding of stress and adverse life events on the sensitivity of the body's protection system adds further support to this (Jones, 2017).

In the last couple of years, the biopsychosocial model has been re-examined. Specialists in pain medicine have promoted a re-prioritisation of the framework, adopting the term *socio-psycho-biomedical* in order to emphasise social components (Moore & Davies, 2018). This change parallels an earlier revision by Sommers-Flanagan and Campbell (2009) who suggested a socio-psycho-bio model. Fillingim (2017), in reviewing the application of the biopsychosocial model, described the concept of the *mosaic* of pain. The biopsychosocial interactions, he argued, demand that clinicians recognise individual differences in pain experience to achieve the best outcomes (Fillingim, 2017). In their comprehensive review, Stilwell and Harman (2019) concluded that the biopsychosocial model is often inappropriately applied leading to a focus on the biological aspects of pain and, in effect, continuing a reductionist approach that the early proponents of the framework were trying to avoid. Taking things forward, the authors build on previous work (i.e. 4E cognition model (Newen, De Bruin, & Gallagher, 2018), applying it to the context of pain. As well as the original four Es – embodied, embedded,

enacted, extended – the authors added an additional fifth E, emotive (Stilwell & Harman, 2019).

The concept of pain being embodied and embedded was nicely described in a 2017 review (Tabor, Keogh, & Eccleston, 2017). The authors emphasised that *pain and action* combine as a defence to preserve homeostasis. Importantly *action* includes conscious and unconscious function including neuro-immune-endocrine responses. This reflects much earlier thinking by Cott and colleagues (1995) who adopted an inclusive description of *movement* in their Movement Continuum Theory of physiotherapy. *Embodied* pain can be considered to involve an inference or predictive component, shaping perception to managing uncertainty, a liminal component, related to the disruption of normal processing, and a defence component with pain being the motivation for action (Tabor et al., 2017; Tabor, Van Ryckeghem, & Hasenbring, 2020). The *embedded* component emphasises the interaction of the body and the environment and, in the experience of pain, the importance of context and inferred threat (Tabor et al., 2017).

An extension of an embodied and embedded view, is that pain can also be considered enacted, extended and emotive, involving actions, perceptions and frameworks where the body and world interact, and are inseparable. In terms of clinical reasoning, this approach to the pain experience has been applied using four concepts: body schema, body image, sense of ownership, and sense of agency (Øberg, Normann, & Gallagher, 2015). There are discussions to be drawn from this that I feel are beyond the scope of this thesis but relate to the *movement* concept within the Pain and Movement Reasoning Model. These include variations in movement based on intention and sense of agency, conscious and unconscious control of movement, and, of course, the sociocultural and sociopolitical environment with which pain and movement occur. Future revisions of the Pain and Movement Reasoning Model will need to consider these

important ideas, however, they do align with the original conception of the integrated nature of pain and movement.

In summary, this ongoing examination of the biopsychosocial model and its application to pain and movement is important in any discussion about the Pain and Movement Reasoning Model. However, for now I do not believe the tenets of this thesis are threatened by these recent re-evaluations of the biopsychosocial approach. The criticisms are largely targeting the application of the approach, not the conceptual idea of an integrated, interdependent model of health. However, it will be valuable to re-examine a key outcome measure used in the empirical research, which aims to distinguish between biomedical and biopsychosocial attitudes and beliefs. I do this in Section 8.2.1.

### 8.1.2 Evolving professional communities of practice

For many years in Australia, there had been resistance from the national professional body, the Australian Physiotherapy Association, to requests for an independent and dedicated group for members with a special interest in pain. After some intensive lobbying in 2013 and 2014, the National Pain Group was established and I became the inaugural Chair. This Group worked to create a truly national network, provide a voice for those who were working in pain-focused clinical settings, and engage with other clinical groups to ensure contemporary concepts of pain were being adopted nationally.

My term finished in 2017, and the National Pain Group has continued to have a strong influence on advocating for better awareness of evidence-based pain management among the Association's members. There has been a pain training course established, providing a standard for pain education across all the Association's clinical groups. In addition, physiotherapists who satisfy criteria set by the Group, are awarded a title of *Pain Physiotherapist,* in recognition of this type of expertise. As well, there are

currently six registrars enrolled in the Association's specialisation program. These will be the first Fellows of the Australian College of Physiotherapists specialising in pain.

These enhancements in the professional identity of physiotherapists who predominantly work with people in pain and the improved access to reliable pain education, is a different context to the origins of the thesis. The contextualisation of the findings in the subsequent section will be impacted by how effective these changes are in promoting pain literacy across the profession.

## 8.2 Learnings from the research project

The aims of the thesis were:

- To evaluate the *utility* of the Pain and Movement Reasoning Model and examine its *suitability* in different clinical areas as perceived by physiotherapists working in those areas.
- To identify the impact of educating physiotherapists about the Pain and Movement Reasoning Model in terms of knowledge, attitudes and beliefs about pain and person-centred care.

### 8.2.1 Suitability and utility of the Model

My project, described in Chapter 6, confirmed that many physiotherapists have a biopsychosocial way of thinking and working. They approach their clinical role not only thinking about the patient's physical condition but an awareness of their emotions, cognitions and behaviour. It was also apparent that it was established practice, perhaps in some clinical areas more than others, to consider social influences on the patient's presentation and their recovery. Such consideration of psychological and social influences aligns with guidance from the World Confederation of Physical Therapists and

in particular, international guidance on approaches to ways of thinking and practicing that are recommended for working with people with pain (Buchbinder et al., 2018).

I would argue that some of the examples of practice described by participants, demonstrate the biopsychosocial approach has been adopted informally or incidentally; perhaps simply as an extension of the physiotherapist's socially-learned way of interacting with people. There was a large variation however. Newer graduates reported in the study that their training made them well aware of biopsychosocial interactions and influences. It also seems true that some of the more experienced physiotherapists, through reflective practice, value the psychological and social domains more strongly than some of their peers.

The variation I am describing here, may also reflect a low threshold for what is considered an *application* of the biopsychosocial model. According to Fillingim (2017) and Stilwell and Harman (2019) (see Section 8.1.1), we should be alert to applications of the biopsychosocial model that are reductionist, and do not embrace an approach to pain that recognises the uniqueness of the individual. I would argue that an example of this type of misconception is represented in Ford and colleagues' (2019; 2016) clinical research into low back pain. While describing their approach as *reflective of the biopsychosocial model* (Ford et al., 2019), the main intention of their work seems to be to categorise participants based on clinical presentation, with emphasis on assigning participants to subgroups by pathoanatomic factors (Ford et al., 2016). For example, the subgroups they create include reference to *discogenic pain* and *zygapophyseal joint pain* (Ford et al., 2016). This would seem to be dismantling the biopsychosocial model in order to apply it. Such misconceptions of a biopsychosocial approach to pain were not specifically explored with the participants in my project, but it would seem important to further define, and benchmark, what ways of thinking and practicing should be considered as *biopsychosocial*.

I believe it is valuable to make a distinction between a biopsychosocial way of thinking and practicing, and psychologically informed practice. Psychologically informed practice takes the application of the biopsychosocial model to a more formal level, by attending to processes, concepts or strategies supported by psychological theory and research. This includes understanding the importance of nurturing the therapeutic alliance, not just as a way of achieving a safe relationship and putting the person at ease, but because it impacts on healthful neuro-immune-endocrine responses (i.e. integrated biopsychosocial effect). It also means recognising that encouraging someone to achieve appropriate functional goals, not only provides an indication of improvement but, through verbal encouragement and the resultant mastery of an activity, builds self-efficacy too. Being psychologically informed also means adopting strategies such as motivational interviewing where the emphasis is supporting the person to find their own motivation, rather than being the motivator. It may be that there is a broad scope of practice that could be described as *biopsychosocial* but being psychologically informed may lead to more effective outcomes than incidental approaches that develop through experience and social learning.

The Pain and Movement Reasoning Model as presented in this research does not demand a psychologically informed approach. It does demand a biopsychosocial way of thinking and working. In this way, it provides a good foundation to clinical reasoning about pain because users can apply their current understanding of pain, at whatever level, to the Model. The finding that the Model was suitable for use in a range of clinical areas reflects this and also that a biopsychosocial approach, in some form, is common in physiotherapy practice. Of course, by allowing users to apply the Model at their level means that all physiotherapists including experts can use the Model to support their reasoning.  For example, registrars in their specialisation training with the

Australian College of Physiotherapy, have incorporated it into their presentations (Doherty, 2020; Stalioraitis, 2016).

Notably, some participants in my project reported the Model made them more attentive to aspects that they habitually consider in the reasoning process, and led to them addressing psychological and social aspects more directly and more promptly. The adoption of the Model by other educators into their training, seems to be motivated by similar observations (Robertson, 2017). Claire Robertson (2017) a physiotherapist and educator with expertise in patellofemoral pain, described the importance of the meaning of pain and crepitus to the patient, and also understanding social factors such as inability to work. Shan Morrison (2018) a physiotherapist who is recognised for her expertise on the pelvic floor, described using the Model to lead discussion of the concurrent contributors to pelvic pain experiences with patients. She reported that the *local* tissue factors may be the place to 'start the conversation' about the complexity of pain. Dr. David Kelly (personal communication, 25th October, 2019) described using the Model to emphasise the cognitive and emotional elements of pain in a range of education contexts most recently his presentation on pain in survivors of torture at the national conference of the Australia Physiotherapy Association in 2019. These examples, and the study participants' commentary on ways in which the Model enhanced practice, supports the suitability and utility of the Pain and Movement Reasoning Model in physiotherapy practice.

### 8.2.2 Improving pain literacy

Chapter 5 reports on the education intervention to improve physiotherapists' pain literacy. The intervention was developed from my previous work on skill development and reflected current education concepts and evidence-based strategies. It was well

received by participants and the use of the Pain Reasoning Records promoted reflection on clinical decision-making.

Following the education intervention there were improvements in participants' pain knowledge and a shift away from biomedical attitudes and beliefs about pain (see Section 5.4). This was especially so in the subset of participants who, based on the Pain Attitudes and Beliefs Scale for Physical Therapists (PABS-PT), scored in the high range for biomedical attitudes and beliefs. The moderate effect sizes that accompanied these results support the efficacy of the intervention, especially given its short duration and that a number of participants were already demonstrating high levels on the measures of pain literacy, prior to the education intervention.

From the discussion of the adequacy of the biopsychosocial model (see Section 8.1.1), I would like to reflect on the PABS-PT and its biopsychosocial subscale. Early descriptions of the subscale referred to it as reflecting a behavioural orientation (Ostelo, Stomp-van den Berg, Vlaeyen, Wolters, & De Vet, 2003). However, all the subsequent descriptions of this scale have adopted the term 'biopsychosocial' and so I have complied with that in my submitted papers (Chapters 5 and 6). If I am defining *biopsychosocial* by the integration of its components, and I am also promoting that a biopsychosocial approach is important for pain literacy, then arguably a high score on this PABS-PT subscale is not indicative of pain literacy but a more behavioural orientation towards pain. I have been guarded about the conclusions drawn about this subscale, as the below-target sample size and the high scoring of some participants pre-education, impacted on the detectable change in participants' response. This reinforces that the more important findings of my doctoral project are the shift away from a biomedical orientation.

Person-centredness was measured using the Patient-Practitioner Orientation Scale (PPOS) (Krupat, Yeager, & Putnam, 2000). In personal correspondence, the

creator of the scale was cautious about the scale sensitivity for detecting change (E. Krupat, 3rd August, 2016). The aspect of person centredness I was especially interested in was the incorporation of the person's life story into therapeutic discussion and decision-making. This aligns with the items that make up the *caring* subscale of the PPOS and there were no changes in pre-education and post-education measures (Section 5.4). As reported in Chapter 5, there are other studies that have incorporated this scale in pre-test and post-test methodology, which also found no change in the *caring* subscale following the educational intervention. One of these involved 32 contact hours of education, with a specific focus on person centred care, and improvement *was* reported in the total PPOS and the sharing subscale (Ross & Haidet, 2011) and the other was a one day course with no change in PPOS scores (Wang et al., 2018). The education intervention presented in my doctoral project may need to be enhanced to improve change in this measure of person centeredness but, as the creator had forewarned, the scale may just lack the sensitivity to detect change in this context.

## 8.3 Strengths and limitations

My extensive experience as an educator and clinician, and my established knowledge and clinical approach to pain, have been valuable in preparing this thesis and designing the empirical research project. I have well developed skills in curriculum design and lesson planning and experience in development and delivery of blended learning activities. As a co-creator of the Pain and Movement Reasoning Model and having presented it to a range of different groups (i.e. different disciplines and in different countries), I had learned ways for introducing and supporting its adoption. This included promoting the Model as a tool that enhances existing reasoning, rather than a new way of thinking, and to encourage users to adapt the labels to suit their clinical context. This

contributed to the development of a brief work-based intervention, based on educational research and theory, that was well received by the participants and also effective.

Of course, my experience and, in particular, my involvement in the development of the Model also creates some limitations. By being invested in the Model in this way, there is a risk, despite best intentions, of bias in the way I delivered the education, analysed the data and the interpreted the results. Having a well-considered and established viewpoint makes it difficult to be objective and can hinder the identification and celebration of new viewpoints. However, I tried to mitigate this in a number of ways. For the data collection, I recruited an independent research assistant to conduct the focus groups and interviews. I involved my supervisors – non-physiotherapist clinician/academics – in discussions and decisions about analysis and interpretation. And, in order to increase trustworthiness of the results, I shared findings and conclusions with the local coordinators and a group of the participants. Despite implementing these strategies, the situation where I was evaluating a reasoning tool that I had developed, remains a limitation to the project.

I was disappointed with the completion rates of the Pain Reasoning Records (see Chapter 5 – Section 5.3). However, I understand and accept the difficulties for clinicians when trying adopt a new process into a busy routine. Ideally, I would have liked to collect the Records at the end of each week of the consolidation phase. I suspect the completion rate could be improved with this regular collection and remind participants of the expectation regarding the task. This would also allow for analysis and, importantly, feedback during the consolidation phase. The Records provided interesting insight into the reasoning process and although they were co-designed with one of the local co-ordinators, a broader consultation might have resolved the issues raised by some participants, who felt more detail and guidance was required and the amount of space available for documenting the reasoning process was inadequate. Further development

of the Pain Reasoning Record could consider an electronic version or application software.

The other limitations relate to the intrinsic difficulties of running clinical research which challenge theoretical ideals. In the first instance, it would be ideal to have included a patient voice into the evaluation of any change in the physiotherapist participants' person-centred approach. Unfortunately, the attempt to do so came up against multiple challenges (see Section 4.3). Clinical research should involve patients both in the planning of projects and as participants. I feel disappointed that our initial plan to capture patient responses about the care they were receiving, could not be employed. A greater understanding of physiotherapists' workflows and bespoke arrangements in different clinical areas could provide a resolution, but also would provide complexity to the study design. It is also important to include the diversity of communities in clinical research and I have learned through this experience about the need to plan and appropriately budget for resources that enable inclusivity in recruitment and participation in research.

Another limitation related to clinical research is the capacity for ongoing review of the effects of an intervention. In this case, it would have been valuable to have a follow-up at 6 months, or even 12 months, after the education intervention to confirm the sustainability of the intervention and to capture new or persisting opinions on the utility of the Model. Limited resources and the apparent transient workforce, at least at one site, did not support planning for this. As well, a number of the participants were in junior positions that involve rotation through different clinical areas where pain may be more or less a focus of assessment and management. This would reduce the value of following up participants, particularly with regard to ongoing use of the Model. Although, it may be valuable to observe the use of the Model by the same individual, across different clinical areas.

Finally, the sample size and data set characteristics (i.e. normality, heteroscedasticty etc.) did not allow confidence in pursuing statistical modeling that may have, in a larger sample, demonstrated relationships between work and personal characteristics and pain literacy changes (Marston, 2010). As the sample size did not reach the numbers that the study was powered for, I also took a conservative approach to the analysis and caution with interpretation of the quantitative data, including the statistically significant findings and moderate effect sizes (Button et al., 2013; Herbert, 2019). Findings of appropriately powered replications of this work is necessary which given the current results, would require at least 250 participants. Although in this study some of the quantitative findings related to attitudes and beliefs are somewhat confirmed by the qualitative data. That is, participants describing an approach to patient management that recognises the multidimensionality of pain and reflecting its biopsychosocial nature.

## 8.4 Contribution to new knowledge

### 8.4.1 Enhanced theoretical foundation for clinical reasoning

In Chapter 2, the focus was on the interaction of neurological, immunological and hormonal actions and their influence on pain. By addressing stress, the stress response and the concept of a *body protection system,* I was able to synthesise an understanding of pain, incorporating stress biology and psychoimmunology in a published book chapter (Jones, 2017). When applied to clinical practice, this provides a theoretical foundation that enhances clinical reasoning with a psycho-neuro-immuno-endocrinological explanation of adverse life events, the therapeutic alliance, person-centred care and the role of stress on pain (Jones, 2017). One of the intentions with the book chapter was to assist the translation of pain science and stress biology into clinical practice.

Anecdotally, it has been reported to me that this chapter has been added to a reading list of a Masters-level physiotherapy program.

In Chapter 3, the focus was on cognitions related to the meaning of pain, safety, threat and vulnerability. The work I presented was collaborative work with Dr. Laura Whitburn. Our conclusions about the social environment and the influence on meaning have impact for those supporting women in labour, but also flags the importance of attending to *context* for all pain (Whitburn & Jones, 2019). The social aspects of pain have not drawn the attention that the biological or psychological aspects of pain have (Tabor et al., 2017). Pain has a clear social role in helping the individual, and social group, identify danger, as well as the individual to express a need for help. The expectations and experiences of women and pain during labour, provides a platform for incorporating social contexts into pain reasoning (Whitburn & Jones, 2019; Whitburn, Jones, Davey, & Small, 2017). By bringing the social contributions to the fore, we have raised other questions about the links between pain and pain behaviours. We postulate on the meaning of pain and explore whether pain, including the intensity, is primarily a tool to attract social support in this context, as opposed to a warning for the individual of impending or actual tissue damage (Whitburn & Jones, 2019). The body of work Dr. Whitburn and I have developed through our collaboration seems well received, with more than 50 Web of Science citations since our first publication six years ago.

### 8.4.2 Improved pain literacy after a brief workplace education intervention

The findings of the empirical research of the thesis (Chapters 5 and 6) provide support for brief pain education in the workplace and the utility of the Pain and Movement Reasoning Model in physiotherapy practice. The pain education intervention, described in detail in Section 5.3, required just 90 minutes of engagement with content plus an opportunity for application in the participants' clinical context. While changes in

questionnaire scores were modest, this proved to be an effective model for delivering education, and improving pain literacy, and was feasible and acceptable to deliver in a clinical work setting. One of the participants felt it would be appropriate to use a similar approach for delivering education for topics in her clinical area. A systematic education initiative, supported by management and employing this model of delivery, has the potential to impact on the pain literacy of an organisation. Where a community of practice is established, the education intervention is likely to also become sustainable.

### 8.4.3 Pain and Movement Reasoning Model utility

Another important outcome was the confirmation of the suitability and utility of the Pain and Movement Reasoning Model, not just in musculoskeletal practice, but a range of clinical areas (Section 6.4). Clinicians, no matter what area they work can be encouraged to consider the Model to support their clinical reasoning about a person's pain. Educators should be confident, based on this study, that the Model can be useful in postgraduate and undergraduate education. The ability for both novice and expert to use the Model to reflect their pain reasoning also reinforces its utility. This utility is extended in Chapter 7, which highlights developing work where the Model is adapted for use in disciplines other than physiotherapy.

## 8.5 Future research

An important next step for research on the Pain and Movement Reasoning Model would be to explore the long term benefits of its use in clinical practice and in education settings. Some participants indicated their intention to continue to use the Model but with the current project we were unable to confirm the sustainability of the education, and its ongoing perceived value. It would also be important to get direct validation of how use of the Model benefits patient care, including accessing patient perspectives and outcomes.

This should be a priority as the potential benefits of the use of the Model on patient care will need to be identified, to support any larger investigations. Given my failed attempt to capture the patient voice in this doctoral research (see Section 4.3), careful planning with clinical partners would be necessary, including the consideration of alternate study designs.

One aspect of the doctoral project that remained under-explored, was the modification of the Model for different clinical contexts. This may become more apparent as the Model is adapted for application into different disciplines, as with the Breastfeeding Pain Reasoning Model (Amir, Jones, & Buck, 2015). It would also be valuable to see how clinicians might change their implementation or interpretation of the Model's categories over time and if, with more experience with the Model, clinicians became more comfortable presenting it to patients directly. In the current project, a small number of participants did with some success, but others reported barriers. Further research would enable the barriers to using the Model with patients, such as characteristics of the patient or type of medical condition, to be better identified.

To be able to explore such changes in clinical behaviour and challenges to using the Model, innovative research strategies will be required. Brunner and colleagues (2016) examined the consistency of physiotherapists' recommendations about activity, including work, in response to a clinical vignette and a standardized patient presenting incognito to them in clinic. Consistency of the responses by physiotherapists were compared. Both these methods could be used as a way to measure the effects of training – although a specific measurable clinical behaviour would need to be identified. There was a problem identified by the authors in that the physiotherapists participating in the study, detected the standardized patients 50% of the time which may have impacted on their responses. So while it provides somewhat of a solution, it remains a proxy to

actual measurement of actual patient or clinical outcomes which, as reported by Beneciuk et al (2019), remains troublesome.

A suitable method for these further investigations would be a cluster randomised controlled trial (Campbell, 2014; Marston, 2010). For the use of the Model in clinical practice, this would involve the randomisation of a number of hospitals and health networks into a treatment group, who would receive the brief education intervention, and a second group who would act as control sites. This would make it easier to capture the changes in patient outcomes, as all patients at a particular site would be exposed to the one research condition. For use of the Model in education settings, a similar approach involving education providers could be used.

Importantly, a review of the battery of questionnaires used to assess for characteristics of pain literacy would be required. A more sensitive measure of changes in person centredness should be considered, especially if the brevity of the education interventions is preserved. Also, for testing pain knowledge, it would be wise to either invigilate the completion of questionnaires or select those without easily available answers. This may preclude the use of the revised Neurophysiology of Pain Questionnaire (NPQ-R) for which answers are readily searchable online. The involvement of disciplines other than physiotherapy, would also need to be accommodated, with appropriate questionnaire selection, as well as suitable questionnaires for patients. For patients, commonly used measures of outcome include the Pain Self Efficacy Scale, the Pain Catastrophising Scale, the Depression, Anxiety, Stress Scale, the Brief Pain Inventory and changes in medication use (Tardif, Arnold, Hayes, & Eagar, 2017).

A comprehensive evaluation would also involve qualitative methods. In-depth interviews with a selection of participants, could be used to confirm ways of thinking and practicing including variations in the adoption of a *biopsychosocial approach*. The

interviews would also offer an opportunity to explore the application of the Pain and Movement Reasoning Model, within individualised approaches to clinical reasoning about pain, and elucidate how participants interpret or adapt the three categories for their use. This mixed methods approach would include an *explanatory sequential* design (i.e. interviews used to help interpret and explain questionnaire results) – or *concurrent design* (i.e. interviews and questionnaire results used to form a *convergent* interpretation of the use of the Model; Doyle, Brady, & Byrne, 2016). Interviews could also be used to elicit an understanding of the sustainability of the intervention including ways of thinking and practicing and strategies for ongoing application of the Model. Serial interviews may further contribute to our understanding of clinical reasoning by individual clinicians, or the changes to the patient experience, over time (Murray et al., 2009). Considering that pain is an individual subjective experience and clinical reasoning is also quite individualised, capturing the lived experience of patients and clinicians through qualitative research methods would be important.

## 8.6 Concluding comments

People with pain should have access to health professionals who can offer optimal advice, care and support. Physiotherapists should adopt a biopsychosocial way of thinking and practicing to optimally help people with pain. There is evidence that physiotherapists find it difficult to modify their approach which is historically drawn from biomedical or pathoanatomic traditions. The Pain and Movement Reasoning Model supports the application of contemporary pain science, where pain is conceptualised as primarily part of the body's protection system. I have provided further evidence for this conceptualisation by exploring the psychoneuroimmunoendocrinology of stress and pain, and by exploring the social environment of the birthing woman and her sense of safety or vulnerability.

This thesis describes a successful education intervention, incorporating the Pain and Movement Reasoning Model, that was brief and able to be applied in the workplace. While the quantitative changes were small, when combined with the qualitative findings, our results suggest the education was demonstrably biomedical subscale effective in altering three characteristics of pain literacy: pain knowledge, pain attitudes and beliefs and person-centred approaches to care. With some minor modifications to improve support and engagement during the consolidation phase of the intervention, this brief pain education process has the potential to be adaptable to different disciplines and clinical contexts.

The Pain and Movement Reasoning Model also provides a method for how the biopsychosocial model can be directly applied to pain reasoning. This application will always be limited by the clinician's interpretation of the *biopsychosocial* approach. When used as a reasoning tool the Pain and Movement Reasoning Model embraces an understanding that recognises pain is dynamic and influenced concurrently by multiple mechanisms from the person's past and current contexts. In deciding which category of mechanisms, moderators and mediators predominates, the clinician is forced to engage with all aspects of the person's pain experience. The recognition that pain is a whole person experience guides a broader range of treatment options for the person's pain. This was true for participants in the study, who also reflected on the increased confidence they had for treatment decisions and for educating people with pain about the influences on their pain experience.

This thesis has confirmed there is value in considering the Pain and Movement Reasoning Model in further investigations of pain reasoning, and pain education. This needs to be considered in relation to the changing contexts related to the conceptualisation of pain and professional knowledge and development. Further

research is required to confirm the impact of the education intervention on pain literacy and to explore the suitability and utility in disciplines other than physiotherapy.

Across the duration of my PhD candidature, research and analysis has confirmed and re-confirmed that pain is biopsychosocial in nature and is best managed using a biopsychosocial approach. Increasingly it is apparent that this applies to all pain and not just persistent musculoskeletal pain. As professional groups, policy makers and funders of health care respond to this, it is likely that both clinicians and educators will be open to approaches that support an integrated biopsychosocial model of pain. The adoption of the Pain and Movement Reasoning Model may be one way to facilitate this.

## 8.7 References


Amir, L. H., **Jones, L. E.**, & Buck, M. L. (2015). Nipple pain associated with breastfeeding: incorporating current neurophysiology into clinical reasoning. *Australian Family Physician, 44*(3), 127-132.

Benedetti, F. (2013). Placebo and the new physiology of the doctor-patient relationship. *Physiological Reviews, 93*(3), 1207-1246.

Buchbinder, R., van Tulder, M., Öberg, B., Costa, L. M., Woolf, A., Schoene, M., . . . Menezes Costa, L. (2018). Low back pain: A call for action. *The Lancet, 391*(10137), 2384-2388. doi:10.1016/S0140-6736(18)30488-4

Button, K. S., Ioannidis, J. P., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, 14(5), 365-376.

Campbell, M. J. (2014). *How to Design, Analyse and Report Cluster Randomised Trials in Medicine and Health Related Research*: Chichester, UK: Wiley.

Cott, C. A., Finch, E., Gasner, D., Yoshida, K., Thomas, S. G., & Verrier, M. C. (1995). The Movement Continuum Theory of physical therapy. *Physiotherapy Canada, 47*(2), 87-95.

Denk, F., & McMahon, S. B. (2012). Chronic pain: emerging evidence for the involvement of epigenetics. *Neuron, 73*(3), 435-444.

Denk, F., McMahon, S. B., & Tracey, I. (2014). Pain vulnerability: A neurobiological perspective. *Nature Neuroscience, 17*(2), 192-200.

Doherty, D. (2020). Pain Registrar Case Study: Australian Physiotherapy Association.

Doyle, L., Brady, A.-M., & Byrne, G. (2016). An overview of mixed methods research–revisited. *Journal of Research in Nursing, 21*(8), 623-635.

Fillingim, R. B. (2017). Individual differences in pain: Understanding the mosaic that makes pain personal. *Pain, 158*(Suppl 1), S11.

Ford, J., Hahne, A., Surkitt, L., Chan, A., & Richards, M. (2019). The evolving case supporting individualised physiotherapy for low back pain. *Journal of Clinical Medicine, 8*(9), 1334.

Ford, J., Hahne, A. J., Surkitt, L. D., Chan, A. Y., Richards, M. C., Slater, S. L., . . . Taylor, N. F. (2016). Individualised physiotherapy as an adjunct to guideline-based advice for low back disorders in primary care: A randomised controlled trial. *British Journal of Sports Medicine, 50*(4), 237-245.

Herbert, R. (2019). Research Note: Significance testing and hypothesis testing: meaningless, misleading and mostly unnecessary. *Journal of Physiotherapy*, 65(3), 178.

**Jones, L. E.** (2017). Stress, pain and recovery: Neuro-immune-endocrine interactions and clinical practice. In S. B. Porter (Ed.), *Psychologically Informed Physiotherapy: Embedding Psychosocial Perspectives Within Clinical Management*, pp. 78-106. Edinburgh, UK: Elsevier.

**Jones, L. E.**, & O'Shaughnessy, D. F. P. (2014). The Pain and Movement Reasoning Model: Introduction to a simple tool for integrated pain assessment. *Manual Therapy, 19*(3), 270-276.

Krupat, E., Yeager, C. M., & Putnam, S. (2000). Patient role orientations, doctor-patient fit, and visit satisfaction. *Psychology and Health, 15*(5), 707-719.

Marston, L. (2010). *Introductory Statistics for Health and Nursing*, London, UK: SAGE Publications.

Moore, D., & Davies, P. (2018). The problem of chronic pain and scope for improvements in patient outcomes. Retrieved from http://fpm.anzca.edu.au/documents/fpm-sapere-pain-medicine-report.pdf

Morrison, S. (2018). *Pelvic pain in men*. Retrieved from https://youtu.be/_Xie8zp5Br0

Murray, S. A., Kendall, M., Carduff, E., Worth, A., Harris, F. M., Lloyd, A., . . . Sheikh, A. (2009). Use of serial qualitative interviews to understand patients' evolving experiences and needs. *BMJ*, 339, b3702.

Nesse, R. M., & Schulkin, J. (2019). An evolutionary medicine perspective on pain and its disorders. *Philosophical Transactions of the Royal Society B, 374*(1785), 20190288.

Newen, A., De Bruin, L., & Gallagher, S. (2018). *4E Cognition* (1 ed.): Oxford University Press.

Øberg, G. K., Normann, B., & Gallagher, S. (2015). Embodied-enactive clinical reasoning in physical therapy. *Physiotherapy Theory and Practice, 31*(4), 244-252.

Ostelo, R. W., Stomp-van den Berg, S. G., Vlaeyen, J. W., Wolters, P. M., & De Vet, H. C. (2003). Health care provider's attitudes and beliefs towards chronic low back pain: the development of a questionnaire. *Manual Therapy, 8*(4), 214-222.

Robertson, C. (2017). *Top tips Pain and Movement Reasoning Model*. Retrieved from https://youtu.be/YuQALRxhVVo

Ross, E. F., & Haidet, P. (2011). Attitudes of physical therapy students toward patient-centered care, before and after a course in psychosocial aspects of care. *Patient Education and Counseling, 85*(3), 529-532.

Sommers-Flanagan, J., & Campbell, D. G. (2009). Psychotherapy and (or) medications for depression in youth? An evidence-based review with recommendations for treatment. *Journal of Contemporary Psychotherapy, 39*(2), 111-120.

Stalioraitis, V. (2016). Neck-related arm pain. May issue, *InMotion,* 79-82. Retrieved from https://australian.physio/inmotion/archive.

Stilwell, P., & Harman, K. (2019). An enactive approach to pain: Beyond the biopsychosocial model. *Phenomenology and the Cognitive Sciences, 18*(4), 637-665.

Tabor, A., Keogh, E., & Eccleston, C. (2017). Embodied pain—negotiating the boundaries of possible action. *Pain, 158*(6), 1007-1011.

Tabor, A., Van Ryckeghem, D. M., & Hasenbring, M. I. (2020). Pain unstuck: The role of action and motivation. *The Clinical Journal of Pain, 36*(3), 143-149.

Tardif, H., Arnold, C., Hayes, C., & Eagar, K. (2017). Establishment of the Australasian electronic persistent pain outcomes collaboration. *Pain Medicine, 18*(6), 1007-1018.

Walters, E. T., & Williams, A. C. d. C. (2019). Evolution of mechanisms and behaviour important for pain. *Philosophical Transactions of the Royal Society B, 374*, 20190275. http://dx.doi.org/10.1098/rstb.2019.0275

Wang, A. P., Fisher, G., & Hall, J. (2018). Pain education for clinicians in geriatrics: A study into changes in clinician attitudes and beliefs. *Health Education in Practice, 1*(1), 51-68.

Whitburn, L. Y., & **Jones, L. E.** (2019). Labour pain. In S. van Rysewyk (Ed.), *Meanings of Pain* (Vol. 2), pp. 143-162: Springer.

Whitburn, L. Y., **Jones, L. E.**, Davey, M.-A., & Small, R. (2017). The meaning of labour pain: How the social environment and other contextual factors shape women's experiences. *BMC Pregnancy and Childbirth, 17*, 157. https://doi.org/10.1186/s12884-017-1343-3

# Appendix A: Ethics approval for the doctoral research project

Research procedures for the doctoral research project presented in Chapters 5 and 6 were approved by Austin Health Human Research Ethics Committee (reference HREC17Austin105) and endorsed by La Trobe University College of Science Health and Engineering Human Ethics Sub-Committee (reference HREC17Austin105-Amir). Governance processes were completed at Northern Health and St. Vincent's Melbourne and the Eastern Health Research Ethics Committee (reference E21/0708). Documentation of these approvals are provided in this Appendix.

Austin Hospital

145 Studley Road
PO Box 5555 Heidelberg
Victoria Australia 3084
Telephone 03 9496 5000
Facsimile 03 9458 4779
www.austin.org.au

## AUSTIN HEALTH HUMAN RESEARCH ETHICS COMMITTEE

## ETHICAL APPROVAL

A/Prof Lisa Amir
La Trobe University

25 August 2017

Dear A/Prof Lisa Amir,

**HREC Reference Number:** HREC/17/Austin/105

**Austin Health SITE REFERENCE Number:** LNRR 17/105

**Project Title:** The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings

---

I am pleased to advise that the above project has **received ethical approval** from the Austin Health Human Research Ethics Committee (HREC). The HREC confirms that your proposal meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). This HREC is organised and operates in accordance with the National Health and Medical Research Council's (NHRMC) National Statement on Ethical Conduct in Human Research (2007), and all subsequent updates, and in accordance with the Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95), the Health Privacy Principles described in the Health Records Act 2001 (Vic) and Section 95A of the Privacy Act 1988 (and subsequent Guidelines).

**HREC Approval Date:** 25 August 2017

**Ethical approval for this project applies at the following sites:**

| Site |
|---|
| Northern Health |
| St Vincent's Hospital, Melbourne |

**Approved Documents:**

The following documents have been reviewed and approved:

| Document | Version | Date |
|---|---|---|
| LNR Vic (AU/13/791038) | | 21 August 2017 |
| Protocol | 3.3 | 16 August 2017 |
| PICF Master Physiotherapist | 2.0 | 13 June 2017 |
| PICF Master Patient | 2.0 | 13 June 2017 |
| Email Script to interested physiotherapists | 1.0 | 29 May 2017 |
| Script for recruitment of patient participants | 2.1 | 27 June 2017 |
| Questionnaire Physiotherapist Participants | 1.2 | 07 May 2017 |
| Questionnaire Patient Participants | 1.2 | 07 May 2017 |
| Pain Reasoning Record Template | 1.2 | 07 May 2017 |
| Focus Group and Interview Guide | 1.0 | 29 May 2017 |
| YouTube Information Session (https://www.youtube.com/watch?v=LVZ3FNXPMj8) | N/A | N/A |
| Online Learning Intervention (https://v3.pebblepad.com.au/spa/#/public/yqqhw75jqbdR4sc7t9fq5zs4r?historyId=CyLSEueTK2&pageId=yqqhw75jqbdR5ygdycW9zjgnhr) | N/A | N/A |
| Education Intervention Slides | 1.0 | 13 June 2017 |

**Governance Authorisation:**

Governance Authorisation is required at each site participating in the study before the research project can commence at that site.

You are required to provide a copy of this HREC approval letter to the principal investigator for each site covered by this ethics approval for inclusion in the site specific assessment application.

**Conditions of Ethics Approval:**

- You are required to submit to the HREC:
    - An Annual Progress Report (that covers all sites listed on approval) for the duration of the project. This report is due on the anniversary of HREC approval. Continuation of ethics approval is contingent on submission of an annual report, due within one month of the approval anniversary. Failure to comply with this requirement may result in suspension of the project by the HREC.
    - A comprehensive Final Report upon completion of the project.
- Submit to the reviewing HREC for approval any proposed amendments to the project including any proposed changes to the Protocol, Participant Information and Consent Form/s and the Investigator Brochure.
- Notify the reviewing HREC of any adverse events that have a material impact on the conduct of the research in accordance with the NHMRC Position Statement: *Monitoring and reporting of safety for clinical trials involving therapeutic products May 2009*.
- Notify the reviewing HREC of your inability to continue as Coordinating Principal Investigator.
- Notify the reviewing HREC of the failure to commence the study within 12 months of the HREC approval date or if a decision is taken to end the study at any of the sites prior to the expected date of completion.

- Notify the reviewing HREC of any matters which may impact the conduct of the project.

Please note: Template forms for reporting Amendments, Adverse events, Annual/Final reports, etc. can be accessed from: https://www2.health.vic.gov.au/about/clinical-trials-and-research/clinical-trial-research/how-to-make-an-hrec-application-for-clinical-trials.

The HREC may conduct an audit of the project at any time.

Yours sincerely,

Kelsey Dalton
Research Ethics Officer

LA TROBE UNIVERSITY

**COLLEGE OF SCIENCE, HEALTH & ENGINEERING**

**MEMORANDUM**

---

**To:** **Dr Lisa Amir, School of Nursing & Midwifery**

**Student:** **Lester Jones**

**From:** **Secretariat, SHE College Human Ethics Sub-Committee (SHE CHESC)**

**Reference:** **SHE CHESC acceptance of Austin Health HREC approved project – HREC/17/Austin/105.**

**Title:** **The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings**

**Date:** **29 August, 2017**

---

Thank you for submitting the above protocol to the SHE College Human Ethics Sub-Committee (SHE CHESC). Your material was forwarded to the SHE CHESC Chair for consideration. Following evidence of a full review and subsequent final approval by **The Austin Health HREC**, the SHE CHESC Chair agrees that the protocol complies with the National Health and Medical Research Council's *National Statement on Ethical Conduct in Human Research* and is in accordance with La Trobe University's *Human Research Ethics Guidelines*.

Endorsement is given for you to take part in this study in line with the conditions of final approval outlined by The Austin Health HREC.

**Limit of Approval.** La Trobe SHE CHESC endorsement is limited strictly to the research protocol as approved by The Austin Health HREC.

**Variation to Project.** As a consequence of the previous condition, any subsequent modifications approved by The Austin Health HREC for the project should be notified formally to the SHE CHESC

**Annual Progress Reports.** Copies of all progress reports submitted to The Austin Health HREC are to be forwarded to the SHE CHESC. Failure to submit a progress report will mean that endorsement for your involvement in this project will be rescinded. An audit related of your involvement in the study may be conducted by the SHE CHESC at any time.

**Final Report.** A copy of the final report is to be forwarded to the CHESC within one month of it being submitted by The Austin Health HREC.

If you have any queries related to the information above or require further clarifications, please contact chesc.she@latrobe.edu.au. Please quote reference number **HREC/17/Austin/105 - Amir**.

On behalf of the SHE College Human Ethics Sub-Committee, best wishes with your research!

Ms Kate Ferris
Human Ethics Officer
Secretariat – SHE College Human Ethics Sub-Committee
Ethics and Integrity / Research Office
La Trobe University Bundoora, Victoria 3086
E: chesc.she@latrobe.edu.au
P: (03) 9479 – 3370

Northern Health

# GOVERNANCE AUTHORISATION

## SITE SPECIFIC ASSESSMENT (SSA) APPROVAL TO CONDUCT A RESEARCH PROJECT AT NORTHERN HEALTH

10 October 2017

Mr Lester Jones
215 Franklin St
Melbourne 3000 VIC

Dear Lester,

**LNR Reference No: HREC/17/Austin/105**

**Reviewing Ethics Committee: Austin Health HREC**

**Ethics Committee Approval Date: 25 August 2017**

**LNRSSA Reference No: LNRSSA/17/NH/96**

**LNRSSA Authorisation Code/Date: AU/14/8C80314**

**Project Title: The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings.**

I am pleased to advise that the above project is authorised to be conducted at Northern Health. This approval is subject to compliance with the conditions set out below and any conditions specified by the reviewing Ethics Committee.

**Approved Documents:**

| Document | Version | Date |
|---|---|---|
| SSA (AU/14/8C80314) | | 09 October 2017 |
| NH site specific PICF Physiotherapist | 1.1 | 15 September 2017 |
| NH site specific PICF Patient | 1.1 | 15 September 2017 |
| Research Collaboration Agreement – For an Investigator Initiated Study | | 28 September 2017 |

| Noted Document | Version | Date |
|---|---|---|
| LNR Vic (AU/13/791038) | | 21 August 2017 |

| | | |
|---|---|---|
| Austin Health HREC Ethical Approval Letter | | 25 August 2017 |
| Protocol | 3.3 | 16 August 2017 |
| Master PICF Physiotherapist | 2.0 | 13 June 2017 |
| Master PICF Patient | 2.0 | 13 June 2017 |
| Email Script to interested physiotherapists | 1.0 | 29 May 2017 |
| Script for recruitment of patient participants | 2.1 | 27 June 2017 |
| Questionnaire Physiotherapist Participants | 1.2 | 07 May 2017 |
| Questionnaire Patient Participants | 1.2 | 07 May 2017 |
| Pain Reasoning Record Template | 1.2 | 07 May 2017 |
| Focus Group and Interview Guide | 1.0 | 29 May 2017 |
| Education Intervention Slides | 1.0 | 13 June 2017 |
| YouTube Information Session (https://www.youtube.com/watch?v=LVZ3FNXPMj8) | NA | NA |
| Online Learning Intervention (https://v3.pebblepad.com.au/spa/#/public/yqqhw75jqbdR4sc7t49fq5zs4r?historyId=CyLSEueTK2&pageId=yqqhw75jqbdR5ygdycW9zjgnhr) | NA | NA |
| NH Investigators' CVs – Lester Jones & Hazel Heng | | |

**Research governance**

As Principal Investigator, you are required to:

1. Comply with the Investigator's responsibilities as outlined in the *Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95).*

2. Notify the Ethics & Research Governance Office (ethics@nh.org.au) of:
   - The actual start date of the project at Northern Health.
   - Any amendments to the project after these have been approved by the reviewing Ethics Committee.
   - Any adverse events involving patients of Northern Health, in accordance with the NHMRC Position Statement: *Monitoring and reporting of safety for clinical trials involving therapeutic products May 2009* .
   - Any changes to the indemnity, insurance arrangements or Research Agreement for this project. This includes changes to the project budget or other changes which may have financial or other resource implications at Northern Health.
   - Your inability to continue as Principal Investigator or any other change in research personnel involved in this project.
   - Failure to commence the study within 12 months of the Governance authorisation date or if a decision is taken to end the study at this site.
   - Any other unforeseen events.
   - Any other matters which may impact the conduct of the project at Northern Health.

3. Ensure that Ethics Committee approval remains current for the entire duration of the project. Investigators undertaking projects without current ethical approval risk their indemnity, funding and publication rights.

4. Submit an annual progress report every 12 months for the duration of the project. This report is due on the anniversary of ethical approval. Continued LNRSSA approval is contingent on receipt of an annual report by the RGO. In addition, a comprehensive final report should be submitted to the RGO upon completion of the project.

5. Ensure that the research agreements (as applicable) are fully executed, i.e. signed by all parties; and an original version (or copy) placed in the study file and a copy sent to the RGO.

Please note: Template forms for reporting Amendments, Adverse events, Annual/Final reports, etc. can be accessed from: https://www2.health.vic.gov.au/about/clinical-trials-and-research/clinical-trial-research/how-to-make-an-hrec-application-for-clinical-trials.

The Ethics & Research Governance Officer may conduct an audit of the project at any time.

For further information, please contact Rita Wong/ Jingfei Wu ph: 8405 2918 or ethics@nh.org.au.

Yours sincerely,

Jingfei Wu
Research Governance Officer

ST VINCENT'S HOSPITAL
MELBOURNE
A FACILITY OF ST VINCENT'S HEALTH AUSTRALIA

**St Vincent's Hospital (Melbourne) Limited**
ABN 22 052 110 755

41 Victoria Parade Fitzroy VIC 3065
PO Box 2900 Fitzroy VIC 3065

Telephone 03 9288 2211
Facsimile 03 9288 3399
www.svhm.org.au

06 February 2018

Ms Sophie Heywood
Department of Physiotherapy
St Vincent's Hospital (Melbourne)

Dear Ms Heywood

**LNR HREC reference number: HREC/17/Austin/105**
**LNR/SSA reference number: LNRSSA/18/SVHM/32**
**St Vincent's Local reference number: 020/18**
**Study Title: The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings.**

Thank you for submitting a Site Specific Assessment Form for Governance Approval at St Vincent's Hospital (Melbourne).

I am pleased to inform you that the aforementioned application has been approved.

This HREC is organised and operates in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Research Involving Humans 2007 (updated May 2015), and all subsequent updates, and in accordance with the Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95), the Health Privacy Principles described in the Health Records Act 2001 (Vic) and Section 95A of the Privacy Act 1988 (and subsequent Guidelines).

**SSA Authorisation Date: 06 February 2018**

- **Approval is only granted for Physiotherapist participants.**

**Approved documents**
The following documents have been reviewed and approved:

| Document | Version | Date |
|---|---|---|
| HREC Approval Letter | - | 25/08/2017 |
| Low and Negligible Risk Research Application Form | 1.1 (2014) | 21/08/2017 |
| Low and Negligible Risk Research Site Specific Assessment (SSA) | Feb 2013 | 27/12/2017 |
| Research Protocol | 3.3 | 16/08/2017 |
| Master Participant Information and Consent Form | 2.0 | 13/06/2017 |
| SVHM site specific Information and Consent Form | 1 | 12/12/2017 |
| Physiotherapist Participant Questionnaire | 1.2 | 07/05/2017 |

| | | |
|---|---|---|
| Focus Group and Interview Guide | 1.0 | 29/05/2017 |
| Email Script to Interested Physiotherapists | 1.0 | 29/05/2017 |
| The Pain and Moving Reasoning Model (education intervention) | 1.0 | 13/06/2017 |
| Pain Reasoning Record Template | 1.2 | 07/05/2017 |
| Research Collaboration Agreement | - | 05/02/2018 |

**Noted documents**

The following documents have been reviewed and approved:

| Document | Version | Date |
|---|---|---|
| La Trobe HREC Approval | - | 29/08/2017 |

*Governance Approval is subject to*:

- The Principal Researcher is to ensure that all associate researchers are aware of the terms of approval and to ensure the project is conducted as specified in the application and in accordance with the National Statement on Ethical Conduct in Human Research 2007 (updated May 2015)
- Immediate notification to the Research Governance Unit of any serious adverse events on participants.
- Immediate notification of any unforeseen events that may affect the continuing ethical acceptability of the project;
- Notification and reasons for ceasing the project prior to its expected date of completion;
- Notification of approved amendments to the study.
- **Submit an annual progress report for the duration of the project. This report is due on the 01 May of each year for the duration of the study. Continued SSA approval is contingent on receipt of an annual report by the RGO. In addition, a comprehensive final report should be submitted to the RGO upon completion of the project.**
- Submission of a final report and papers published on completion of project.
- Submission of reviewing HREC approval for any proposed modifications to the project.
- Projects may be subject to an audit or any other form of monitoring by the Research Governance Unit at any time.

If you have any matters that arise regarding conduct of the research at this site, please ensure you contact the Research Governance Unit on 03 9231 2394. Please quote the reference numbers above in all correspondence.

We wish you well with your project.

Yours sincerely,

**Ms Leanne Clinch**
HREC Secretary
Research Governance Unit
St Vincent's Hospital (Melbourne)

# Appendix B: Participant information and consent forms for the doctoral research project

The Participation Information and Consent forms presented to participants of the doctoral research project presented in Chapters 5 and 6 are presented in this Appendix.

# Physiotherapist Participant Information Sheet/Consent Form

**Health/Social Science Research** - *Adult providing own consent*

## NORTHERN HEALTH

| | |
|---|---|
| **Title** | The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings |
| **Short Title** | The utilisation of a clinical reasoning tool for pain |
| **Protocol Number** | HREC/17/Austin/105 |
| **Coordinating Principal Investigator/ Principal Investigator** | Lisa Amir<br>Stephen Kent; Lester Jones |
| **Associate Investigator(s)** | Hazel Heng |
| **Location** | Physiotherapy services across Northern Health |

## Part 1 What does my participation involve?

### 1 Introduction

You are invited to take part in this research project, which is called 'The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings'. You have been invited because you provided your details as a sign of interest at the information session and because you are a physiotherapist and at least some of the patients you treat experience pain.

This Participant Information Sheet/Consent Form tells you about the research project. It explains the processes involved with taking part. Knowing what is involved will help you decide if you want to take part in the research.

Please read this information carefully. Ask questions about anything that you don't understand or want to know more about. Before deciding whether or not to take part, you might want to talk about it with your co-workers or your manager.

Participation in this research is voluntary. If you don't wish to take part, you don't have to.

If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing it you are telling us that you:

- Understand what you have read
- Consent to take part in the research project
- Consent to be involved in the research described
- Consent to the use of your personal information as described.

You will be given a copy of this Participant Information and Consent Form to keep.

## 2 What is the purpose of this research?

This project aims to study the usefulness of a model of reasoning (the Pain and Movement Reasoning Model) designed to enhance the way physiotherapists assess and treat a person's pain. The project will include multiple clinical areas where physiotherapists are working, across at least two hospital networks, in order to determine how the Model is used. A second aim is to assess the impact on physiotherapists of training in the use of the Model. In particular, the impact on physiotherapists' knowledge, attitudes and beliefs about pain and the way they interact with their patients.

To date the Model has been adopted and adapted for a range of situations but it has never formally been assessed. The findings of this study will give weight to further use, adaption and research of the Model as a clinical tool, and may uncover other innovative uses for it.

The results of this research will be used by the researcher Lester Jones to obtain a Doctorate of Philosophy. He is enrolled at La Trobe University.

## 3 What does participation in this research involve?

If you would like to enrol into the study you need to first sign the consent form and return it to the Site Coordinator.

Once we have received your consent form we will contact you and ask you to identify patients who you have been seeing that are close to being discharged from care. We will assist you to invite patients to be part of the study using an informed consent process including provision of a patient-specific Participant Information and Consent Form and a script that you can read to the patient about the study. Depending on local arrangements, you will either provide a copy of a 34 item questionnaire for consenting patient participants to complete in their own time or researchers will follow-up those patients who have given consent and provide them with the questionnaire.

Within three weeks of receiving your consent form you will receive your own questionnaire for completion and return and this must be returned prior to the intervention commencing. The questionnaire will take about 20 minutes to complete.

The intervention consists of three 30-minute education sessions. The first and third sessions will be on-line and allow you to work through resources independently. The middle session will be a face-to-face session delivered by the co-ordinating principal investigator and will be organised in a normal in-service training time or other convenient time. There will be approximately a week between each training session so this part of the education intervention will be three weeks long.

After the training session you will be asked to start completing a template (the Pain Reasoning Record) which allows a brief summary of how you use the Model during clinical interactions to be recorded. These will only take a few minutes to complete. Across the next six weeks, you will have the opportunity to record up to 25 summaries that will be sent back to the researchers for further analysis. We are aware that some participants will not always be working with patients with pain but we hope that the 6-week period allows at least three or four summaries to be completed.

After this 6-week period is complete you will be invited to one of several focus groups to discuss your experience of using the Model with researchers. These will go for no more than an hour with groups of 6-8 participants. These will be audio recorded in order for accurate transcripts to be constructed.

A number of one-to-one interviews will be offered in order for participants to expand on their application or response to the Model. These will be arranged at a convenient time for the participant and run for approximately 30 minutes. These will also be audio recorded in order for accurate transcripts to be constructed. Invitations to attend the interviews will be made after some early analysis of the Pain Reasoning Records and Focus Groups has been completed.

Finally, at about the same time as the Focus Groups are being conducted, we will ask you to again identify patients who you have been seeing that are close to being discharged from care and seek their consent using the informed consent process described above. Researchers will then contact those that consent to be involved and provide them with the same questionnaire as the pre-intervention patients.

This research project has been designed to make sure the researchers interpret the results in a fair and appropriate way and avoids researchers or participants jumping to conclusions. The Coordinating Principal Lecturer, Lester Jones, who has co-designed the Model being evaluated will not be present at Focus Groups or run the interviews which will allow participants to speak freely about the Model.

There are no costs associated with participating in this research project, nor will you be paid.

## 4 Other relevant information about the research project

The project is designed to include two hospital networks initially but may need to expand to achieve adequate sample size. The study has been powered for a sample size of 90. Physiotherapists from all clinical areas and services will be invited to participate.

## 5 Do I have to take part in this research project?

Participation in any research project is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage.

If you do decide to take part, you will be given this Participant Information and Consent Form to sign and you will be given a copy to keep.

Your decision whether to take part or not to take part, or to take part and then withdraw, will not affect your work or work appraisals or relationship with Northern Health.

## 6 What are the possible benefits of taking part?

We cannot guarantee or promise that you will receive any benefits from this research; however, possible benefits may include an enhanced understanding of current concepts of pain and a comprehensive and efficient clinical reasoning process for patients with painful symptoms.

There is also the potential that the use of the Model might be expanded to new areas of clinical practice which may promote better care for patients with pain.

## 7 What are the possible risks and disadvantages of taking part?

Whilst all care will be taken to maintain privacy and confidentiality, you may experience embarrassment if one of the group members were to repeat things said in a confidential group meeting.

### 8 What if I withdraw from this research project?

If you do consent to participate, you may withdraw at any time. If you decide to withdraw from the project, please notify a member of the research team before you withdraw. A member of the research team will inform you if there are any special requirements linked to withdrawing. If you do withdraw, you will be asked to complete and sign a 'Withdrawal of Consent' form; this will be provided to you by the research team.

If you decide to leave the research project, the researchers will not collect additional personal information from you, although personal information already collected will be retained to ensure that the results of the research project can be measured properly and to comply with law. You should be aware that data collected up to the time you withdraw will form part of the research project results. If you do not want your data to be included, you must tell the researchers when you withdraw from the research project.

### 9 Could this research project be stopped unexpectedly?

There is nothing foreseeable that threatens the continuation of this project.

### 10 What happens when the research project ends?

At the end of the project the Co-ordinating Principal Researcher intends to return to each research site to present findings.

## Part 2 How is the research project being conducted?

### 11 What will happen to information about me?

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. Any information obtained in connection with this research project that can identify you will remain confidential. Consent forms with names and codes will be kept separately from coded data in locked cabinets at La Trobe University. This information will be only accessible to the research team. Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law.

The personal information that the research team collect and use is the information you provide in questionnaires. No questions will be asked of patients that can link their questionnaire responses to you or the clinical area you work.

It is anticipated that the results of this research project will be published and/or presented in a variety of forums. In any publication and/or presentation, information will be provided in such a way that you cannot be identified, except with your express permission. When using quotes from focus groups or interviews a pseudonym will be used.

In accordance with relevant Australian and/or Victoria privacy and other relevant laws, you have the right to request access to the information about you that is collected and stored by the research team. You also have the right to request that any information with which you disagree be corrected. Please inform the research team member named at the end of this document if you would like to access your information.

Any information obtained for the purpose of this research project and for the future research described that can identify you will be treated as confidential and securely stored. It will be disclosed only with your permission, or as required by law.

## 12 Complaints and compensation

Should you have any concerns or complaints please contact the relevant person from the contact list below.

## 13 Who is organising and funding the research?

This research project is being conducted by Lester Jones, a PhD candidate at La Trobe University.

## 14 Who has reviewed the research project?

All research in Australia involving humans is reviewed by an independent group of people called a Human Research Ethics Committee (HREC).

The ethical aspects of this research project have been approved by the HREC of Austin Health. This project will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect the interests of people who agree to participate in human research studies.

## 15 Further information and who to contact

The person you may need to contact will depend on the nature of your query. If you want any further information concerning this project or if you have any problems which may be related to your involvement in the project, you can contact the researcher on 03 9479 8888 or any of the following people.

**Clinical contact person**

| | |
|---|---|
| Name | Lester Jones |
| Position | Principal Investigator (Northern Health) |
| Telephone | 0433 947612 |
| Email | jones.le@students.latrobe.edu.au |

For matters relating to research at the site at which you are participating, the details of the local site complaints person are:

**Complaints contact person**

| | |
|---|---|
| Name | Rita Wong |
| Position | Ethics and Research Governance Officer |
| Telephone | 03 8405 2918 |
| Email | ethics@nh.org.au |

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact:

| | |
|---|---|
| Reviewing HREC name | Austin Health Research Ethics Committee |
| HREC Executive Officer | Chelsea Webster |
| Telephone | 03 9496 4090 |
| Email | ethics@austin.org.au |

# Consent Form - *Adult providing own consent*

| | |
|---|---|
| **Title** | The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings |
| **Short Title** | The utilisation of a clinical reasoning tool for pain |
| **Protocol Number** | HREC/17/Austin/105 |
| **Coordinating Principal Investigator/ Principal Investigator** | Lisa Amir/ Stephen Kent, Lester Jones |
| **Associate Investigator(s)** | Hazel Heng |
| **Location** | Physiotherapy services across Northern Health |

**Declaration by Participant**

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research described in the project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time during the project without affecting my future care.

I understand that I will be given a signed copy of this document to keep.

Name of Participant (please print) _____

Signature _____ Date _____

**Declaration by Researcher**[†]

I have given a verbal explanation of the research project, its procedures and risks and I believe that the participant has understood that explanation.

Name of Researcher[†] (please print) _____

Signature _____ Date _____

[†] An appropriately qualified member of the research team must provide the explanation of, and information concerning, the research project.

Note: All parties signing the consent section must date their own signature.

# Form for Withdrawal of Participation - *Adult providing own consent*

| | |
|---|---|
| **Title** | The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings |
| **Short Title** | The utilisation of a clinical reasoning tool for pain |
| **Protocol Number** | HREC/17/Austin/105 |
| **Coordinating Principal Investigator/ Principal Investigator** | Lisa Amir/ Stephen Kent, Lester Jones |
| **Associate Investigator(s)** | Hazel Heng |
| **Location** | Physiotherapy services across Northern Health |

**Declaration by Participant**

I wish to withdraw from participation in the above research project and understand that such withdrawal will not affect my routine care, or my relationships with the researchers or Northern Health.

Name of Participant (please print) _____

Signature _____ Date _____

In the event that the participant's decision to withdraw is communicated verbally, the Senior Researcher must provide a description of the circumstances below.

**Declaration by Researcher**[†]

I have given a verbal explanation of the implications of withdrawal from the research project and I believe that the participant has understood that explanation.

Name of Researcher (please print) _____

Signature _____ Date _____

[†] An appropriately qualified member of the research team must provide information concerning withdrawal from the research project.

Note: All parties signing the consent section must date their own signature.

# Physiotherapist Participant Information Sheet/Consent Form

**Health/Social Science Research** - *Adult providing own consent*

**St. Vincent's Hospital Melbourne**

| | |
|---|---|
| **Title** | The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings |
| **Short Title** | The utilisation of a clinical reasoning tool for pain |
| **Coordinating Principal Investigator/ Principal Investigator** | Lisa Amir<br>Stephen Kent; Lester Jones |
| **Site Principal Investigator/ Associate Investigator** | Sophie Heywood |
| **Location** | St. Vincent's Hospital, Melbourne |

## Part 1 What does my participation involve?

### 1 Introduction

You are invited to take part in this research project, which is called 'The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings'. You have been invited because you provided your details as a sign of interest at the information session and because you are a physiotherapist and at least some of the patients you treat experience pain.

This Participant Information Sheet/Consent Form tells you about the research project. It explains the processes involved with taking part. Knowing what is involved will help you decide if you want to take part in the research.

Please read this information carefully. Ask questions about anything that you don't understand or want to know more about. Before deciding whether or not to take part, you might want to talk about it with your co-workers or your manager.

Participation in this research is voluntary. If you don't wish to take part, you don't have to.

If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing it you are telling us that you:

- Understand what you have read
- Consent to take part in the research project
- Consent to be involved in the research described
- Consent to the use of your personal information as described.

You will be given a copy of this Participant Information and Consent Form to keep.

## 2 What is the purpose of this research?

This project aims to study the usefulness of a model of reasoning (the Pain and Movement Reasoning Model) designed to enhance the way physiotherapists assess and treat a person's pain. The project will include multiple clinical areas where physiotherapists are working, across at least two hospital networks, in order to determine how the Model is used. A second aim is to assess the impact on physiotherapists of training in the use of the Model. In particular, the impact on physiotherapists' knowledge, attitudes and beliefs about pain and the way they interact with their patients.

To date the Model has been adopted and adapted for a range of situations but it has never formally been assessed. The findings of this study will give weight to further use, adaption and research of the Model as a clinical tool, and may uncover other innovative uses for it.

The results of this research will be used by the researcher Lester Jones to obtain a Doctorate of Philosophy. He is enrolled at La Trobe University.

## 3 What does participation in this research involve?

If you would like to enrol into the study you need to first sign the consent form and return it to the Site Coordinator Sophie Heywood

Once we have received your consent form we will contact you and ask you to identify patients who you have been seeing that are close to being discharged from care. We will assist you to invite patients to be part of the study using an informed consent process including provision of a patient-specific Participant Information and Consent Form and a script that you can read to the patient about the study. Depending on local arrangements, you will either provide a copy of a 34 item questionnaire for consenting patient participants to complete in their own time or researchers will follow-up those patients who have given consent and provide them with the questionnaire.

Within three weeks of receiving your consent form you will receive your own questionnaire for completion and return and this must be returned prior to the intervention commencing. The questionnaire will take about 20 minutes to complete.

The intervention consists of three 30-minute education sessions. The first and third sessions will be on-line and allow you to work through resources independently. The middle session will be a face-to-face session delivered by the co-ordinating principal investigator and will be organised in a normal in-service training time or other convenient time. There will be approximately a week between each training session so this part of the education intervention will be three weeks long.

After the training session you will be asked to start completing a template (the Pain Reasoning Record) which allows a brief summary of how you use the Model during clinical interactions to be recorded. These will only take a few minutes to complete. Across the next six weeks, you will have the opportunity to record up to 25 summaries that will be sent back to the researchers for further analysis. We are aware that some participants will not always be working with patients with pain but we hope that the 6-week period allows at least three or four summaries to be completed.

After this 6-week period is complete you will be invited to one of several focus groups to discuss your experience of using the Model with researchers. These will go for no more than an hour with groups of 6-8 participants. These will be audio recorded in order for accurate transcripts to be constructed.

A number of one-to-one interviews will be offered in order for participants to expand on their application or response to the Model. These will be arranged at a convenient time for the participant and run for approximately 30 minutes. These will also be audio recorded in order for accurate transcripts to be constructed. Invitations to attend the interviews will be made after some early analysis of the Pain Reasoning Records and Focus Groups has been completed.

Finally, at about the same time as the Focus Groups are being conducted, we will ask you to again identify patients who you have been seeing that are close to being discharged from care and seek their consent using the informed consent process described above. Researchers will then contact those that consent to be involved and provide them with the same questionnaire as the pre-intervention patients.

This research project has been designed to make sure the researchers interpret the results in a fair and appropriate way and avoids researchers or participants jumping to conclusions. The Coordinating Principal Lecturer, Lester Jones, who has co-designed the Model being evaluated will not be present at Focus Groups or run the interviews which will allow participants to speak freely about the Model.

There are no costs associated with participating in this research project, nor will you be paid.

## 4 Other relevant information about the research project

The project is designed to include two hospital networks initially but may need to expand to achieve adequate sample size. The study has been powered for a sample size of 90. Physiotherapists from all clinical areas and services will be invited to participate.

## 5 Do I have to take part in this research project?

Participation in any research project is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage.

If you do decide to take part, you will be given this Participant Information and Consent Form to sign and you will be given a copy to keep.

Your decision whether to take part or not to take part, or to take part and then withdraw, will not affect your work or work appraisals or relationship with St. Vincent's Hospital, Melbourne.

## 6 What are the possible benefits of taking part?

We cannot guarantee or promise that you will receive any benefits from this research; however, possible benefits may include an enhanced understanding of current concepts of pain and a comprehensive and efficient clinical reasoning process for patients with painful symptoms.

There is also the potential that the use of the Model might be expanded to new areas of clinical practice which may promote better care for patients with pain.

## 7 What are the possible risks and disadvantages of taking part?

Whilst all care will be taken to maintain privacy and confidentiality, you may experience embarrassment if one of the group members were to repeat things said in a confidential group meeting.

### 8 What if I withdraw from this research project?

If you do consent to participate, you may withdraw at any time. If you decide to withdraw from the project, please notify a member of the research team before you withdraw. A member of the research team will inform you if there are any special requirements linked to withdrawing. If you do withdraw, you will be asked to complete and sign a 'Withdrawal of Consent' form; this will be provided to you by the research team.

If you decide to leave the research project, the researchers will not collect additional personal information from you, although personal information already collected will be retained to ensure that the results of the research project can be measured properly and to comply with law. You should be aware that data collected up to the time you withdraw will form part of the research project results. If you do not want your data to be included, you must tell the researchers when you withdraw from the research project.

### 9 Could this research project be stopped unexpectedly?

There is nothing foreseeable that threatens the continuation of this project.

### 10 What happens when the research project ends?

At the end of the project the Co-ordinating Principal Researcher intends to return to each research site to present findings.

## Part 2 How is the research project being conducted?

### 11 What will happen to information about me?

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. Any information obtained in connection with this research project that can identify you will remain confidential. Consent forms with names and codes will be kept separately from coded data in locked cabinets at La Trobe University. This information will be only accessible to the research team. Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law.

The personal information that the research team collect and use is the information you provide in questionnaires. No questions will be asked of patients that can link their questionnaire responses to you or the clinical area you work.

It is anticipated that the results of this research project will be published and/or presented in a variety of forums. In any publication and/or presentation, information will be provided in such a way that you cannot be identified, except with your express permission. When using quotes from focus groups or interviews a pseudonym will be used.

In accordance with relevant Australian and/or Victoria privacy and other relevant laws, you have the right to request access to the information about you that is collected and stored by the research team. You also have the right to request that any information with which you disagree be corrected. Please inform the research team member named at the end of this document if you would like to access your information.

Any information obtained for the purpose of this research project and for the future research described that can identify you will be treated as confidential and securely stored. It will be disclosed only with your permission, or as required by law.

### 12 Complaints and compensation

Should you have any concerns or complaints please contact the relevant person from the contact list below.

## 13 Who is organising and funding the research?

This research project is being conducted by Lester Jones, a PhD candidate at La Trobe University.

## 14 Who has reviewed the research project?

All research in Australia involving humans is reviewed by an independent group of people called a Human Research Ethics Committee (HREC).

The ethical aspects of this research project have been approved by the HREC of Austin Health. This project will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect the interests of people who agree to participate in human research studies.

## 15 Further information and who to contact

The person you may need to contact will depend on the nature of your query. If you want any further information concerning this project or if you have any problems which may be related to your involvement in the project, you can contact the researcher on 03 9479 8888 or any of the following people.

**Clinical contact person**

| | |
|---|---|
| Name | *Sophie Heywood* |
| Position | Patient Liaison Officer at St Vincent's Hospital Melbourne |
| Telephone | (03) 92883108 |
| Email | |

For matters relating to research at the site at which you are participating, the details of the local site complaints person are:

**Complaints contact person**

| | |
|---|---|
| Name | |
| Position | HREC Executive Officer |
| Telephone | 03 9231 2394 |
| Email | research.ethics@svha.org.au |

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact:

| | |
|---|---|
| Reviewing HREC name | St Vincent's Hospital Melbourne HREC |
| HREC Executive Officer | HREC Executive Officer |
| Telephone | 03 92312394 |
| Email | research.ethics@svha.org.au |

# Consent Form - *Adult providing own consent*

| | |
|---|---|
| **Title** | The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings |
| **Short Title** | The utilisation of a clinical reasoning tool for pain |
| **Coordinating Principal Investigator/ Principal Investigator** | Lisa Amir<br>Stephen Kent; Lester Jones |
| **Site Principal Investigator/ Associate Investigator** | Sophie Heywood |
| **Location** | St. Vincent's Hospital Melbourne |

## Declaration by Participant

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research described in the project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time during the project without affecting my future care.

I understand that I will be given a signed copy of this document to keep.

Name of Participant (please print) _____

Signature _____ Date _____

## Declaration by Researcher[‡]

I have given a verbal explanation of the research project, its procedures and risks and I believe that the participant has understood that explanation.

Name of Researcher[†] (please print) _____

Signature _____ Date _____

[†] An appropriately qualified member of the research team must provide the explanation of, and information concerning, the research project.

Note: All parties signing the consent section must date their own signature.

# Form for Withdrawal of Participation - *Adult providing own consent*

| | |
|---|---|
| **Title** | The utilisation of a clinical reasoning tool for pain by physiotherapists working in hospital and community settings |
| **Short Title** | The utilisation of a clinical reasoning tool for pain |
| **Coordinating Principal Investigator/ Principal Investigator** | Lisa Amir<br>Stephen Kent; Lester Jones |
| **Site Principal Investigator/ Associate Investigator** | Sophie Heywood |
| **Location** | St. Vincent's Hospital Melbourne |

**Declaration by Participant**

I wish to withdraw from participation in the above research project and understand that such withdrawal will not affect my routine care, or my relationships with the researchers or with St Vincent's Hospital Melbourne

Name of Participant (please print) _____

Signature _____ Date _____

In the event that the participant's decision to withdraw is communicated verbally, the Senior Researcher must provide a description of the circumstances below.

**Declaration by Researcher**[†]

I have given a verbal explanation of the implications of withdrawal from the research project and I believe that the participant has understood that explanation.

Name of Researcher (please print) _____

Signature _____ Date _____

[†] An appropriately qualified member of the research team must provide information concerning withdrawal from the research project.

Note: All parties signing the consent section must date their own signature.

# Appendix C: Questionnaire used in the doctoral research project

The Questionnaire used to collect pre-education and post-education data in the doctoral research project presented in Chapters 5 and 6 is reproduced in this Appendix.

# Physiotherapist Participant Questionnaire

## As part of the research project:
## 'The utilisation of a clinical reasoning tool for pain'

Research Team:

Lester Jones PhD Candidate

Associate Professor Lisa Amir

Professor Stephen Kent

Version 1.2 / 07.05.2017

# The utilisation of a clinical reasoning tool for pain

This questionnaire asks you to tell us about what you know about pain and how you think about it in your clinical practice. It consists of four sections and will take about 15 to 20 mins to complete. All the information you provide is strictly confidential and no information published about the study will identify any person who has taken part.

About the sections:

**Section A** is designed to collect some background information and is based on what other studies have compared when looking at a pain education process similar to what you will undertake as part of the project.

**Section B** is designed to inform us how you think about pain and uses the common condition of back pain as the focus.

**Section C** is designed to capture your knowledge of pain

**Section D** is focused much more on the clinical interaction you have with your patients and what aspects you feel are important.

Thanks again for your participation in the study, please read instructions for each section carefully and consider and respond to all the questions and statements.

If you wish to make any comments about the questionnaire there is a blank page at the end of this document.

If you have any concerns please contact the research team on 03 9479 8888 or email jones.le@students.latrobe.edu.au or l.amir@latrobe.edu.au , the clinical contact person [insert site contact] or the complaints contact person [insert site contact].

Your involvement in the study project is of course voluntary and you are free to withdraw at any time.

## SECTION A

**PARTICIPANT CODE:**

Please complete the following background information. The information we are gathering reflects that collected in other studies exploring the effectiveness of pain education for health professionals.

Indicate by placing 'X' in appropriate box or writing appropriate value:

GENDER

Female ☐

Male ☐

AGE _____ years

YEARS OF EXPERIENCE

0 – 1 ☐

2 – 5 ☐

6 – 10 ☐

11 – 20 ☐

>21 ☐

| TYPE OF PRACTICE | [primary type] | [secondary type] (if applicable) |
|---|---|---|
| Private Clinic | ☐ | ☐ |
| Hospital Inpatient | ☐ | ☐ |
| Hospital Outpatient | ☐ | ☐ |
| Rehabilitation Clinic | ☐ | ☐ |
| Community Health | ☐ | ☐ |

MAIN CLINICAL AREA _____ (e.g. musculoskeletal; cardiorespiratory)

PRIOR FORMAL PAIN EDUCATION

List type of course (e.g. weekend CPD; Master's degree) and provider (e.g. University; APA)

_____

_____

_____

_____

## SECTION B

**PARTICIPANT CODE:**

The purpose of this list is to help us analyse how you, the therapist, approach the most common forms of back pain. We do not mean back pain resulting from a radicular syndrome, cauda equina syndrome, fractures, infections, inflammation, a tumour or metastasis.

It is not our intention to test your knowledge of back pain. We would simply like to know how you approach the treatment of back pain. We are looking for your opinion; the opinions of others are not relevant.

We are aware that back pain is not commonly treated in some clinical areas but would welcome your opinion even if it is not something you see regularly.

To respond to a statement, please mark the relevant box with an 'X'.

| | Totally disagree | Largely disagree | Disagree to some extent | Agree to some extent | Largely agree | Totally agree |
|---|---|---|---|---|---|---|
| 1) Back pain sufferers should refrain from all physical activity in order to avoid injury | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2) Good posture prevents back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3) Knowledge of the tissue damage is not necessary for effective therapy | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4) Reduction of daily physical exertion is a significant factor in treating back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5) Not enough effort is made to find the underlying organic causes of back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6) Mental stress can cause back pain even in the absence of tissue damage | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7) The cause of back pain is unknown | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8) Unilateral physical stress is not a cause of back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9) Patients who have suffered back pain should avoid activities that stress the back | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10) Pain is a nociceptive stimulus, indicating tissue damage | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11) A patient suffering from severe back pain will benefit from physical exercise | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12) Functional limitations associated with back pain are the result of psychosocial factors | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Totally disagree | Largely disagree | Disagree to some extent | Agree to some extent | Largely agree | Totally agree |

| | Totally disagree | Largely disagree | Disagree to some extent | Agree to some extent | Largely agree | Totally agree |
|---|---|---|---|---|---|---|
| 13) The best advice for back pain is: “Take care” and “Make no unnecessary movements” | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14) Patients with back pain should preferably practice only pain free movements | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15) Back pain indicates that there is something dangerously wrong with the back | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16) The way patients view their pain influences the progress of the symptoms | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17) Therapy may have been successful even if pain remains | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18) Therapy can completely alleviate the functional symptoms caused by back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19) If ADL activities cause more back pain, this is not dangerous | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20) Back pain indicates the presence of organic injury | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21) Sport should not be recommended for patients with back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22) If back pain increases in severity, I immediately adjust the intensity of my treatment accordingly | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23) If therapy does not result in a reduction in back pain, there is a high risk of severe restrictions in the long term | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24) Pain reduction is a precondition for the restoration of normal functioning | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 25) Increased pain indicates new tissue damage or the spread of existing damage | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 26) It is the task of the physiotherapist to remove the cause of back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 27) There is no effective treatment to eliminate back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Totally disagree | Largely disagree | Disagree to some extent | Agree to some extent | Largely agree | Totally agree |

| | Totally disagree | Largely disagree | Disagree to some extent | Agree to some extent | Largely agree | Totally agree |
|---|---|---|---|---|---|---|
| 28) TENS and/or back braces support functional recovery | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 29) Even if the pain has worsened, the intensity of the next treatment can be increased | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 30) If patients complain of pain during exercise, I worry that damage is being caused | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 31) The severity of tissue damage determines the level of pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 32) A rapid resumption of daily activities is an important goal of the treatment | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 33) Learning to cope with stress promotes recovery from back pain | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 34) Exercises that may be back straining should not be avoided during the treatment | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 35) In the long run, patients with back pain have a higher risk of developing spinal impairments | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 36) In back pain, imaging tests are unnecessary | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Totally disagree | Largely disagree | Disagree to some extent | Agree to some extent | Largely agree | Totally agree |

## SECTION C

**PARTICIPANT CODE:**

READ the following statements about pain and indicate with a 'X' whether you believe them to be **TRUE** (T), **FALSE** (F) or you are **UNDECIDED** (U)

| | | T | F | U |
|---|---|---|---|---|
| 1. | It is possible to have pain and not know about it. | | | |
| 2. | When part of your body is injured, special pain receptors convey the pain message to your brain. | | | |
| 3. | Pain only occurs when you are injured or at risk of being injured. | | | |
| 4. | When you are injured, special receptors convey the danger message to your spinal cord. | | | |
| 5. | Special nerves in your spinal cord convey 'danger' messages to your brain. | | | |
| 6. | Nerves adapt by increasing their resting level of excitement. | | | |
| 7. | Chronic pain means that an injury hasn't healed properly. | | | |
| 8. | The body tells the brain when it is in pain. | | | |
| 9. | Nerves adapt by making ion channels stay open longer. | | | |
| 10. | Descending neurons are always inhibitory. | | | |
| 11. | Pain occurs whenever you are injured. | | | |
| 12. | When you injure yourself, the environment that you are in will not affect the amount of pain you experience, as long as the injury is exactly the same. | | | |
| 13. | The brain decides when you will experience pain. | | | |

## SECTION D

**PARTICIPANT CODE:**

The statements below refer to beliefs that people might have concerning physiotherapists, patients, and physiotherapy. Read each item and then mark the circle with an 'X' to indicate how much you, a physiotherapist, agree or disagree with each.

| | | Strongly disagree | Moderately disagree | Slightly disagree | Slightly agree | Moderately agree | Strongly agree |
|---|---|---|---|---|---|---|---|
| 1. | The physiotherapist is the one who should decide what gets talked about during a visit. | O | O | O | O | O | O |
| 2. | Although health care is less personal these days, this is a small price to pay for medical advances. | O | O | O | O | O | O |
| 3. | The most important part of the standard physiotherapy visit is the physical exam. | O | O | O | O | O | O |
| 4. | It is often best for patients if they do not have a full explanation of their medical condition. | O | O | O | O | O | O |
| 5. | Patients should rely on their physiotherapists' knowledge and not try to find out about their conditions on their own. | O | O | O | O | O | O |
| 6. | When physiotherapists ask a lot of questions about a patient's background, they are prying too much into personal matters. | O | O | O | O | O | O |
| 7. | If physiotherapists are truly good at diagnosis and treatment, the way they relate to patients is not that important. | O | O | O | O | O | O |
| 8. | Many patients continue asking questions even though they are not learning anything new. | O | O | O | O | O | O |
| 9. | Patients should be treated as if they were partners with the physiotherapist, equal in power and status. | O | O | O | O | O | O |
| 10. | Patients generally want reassurance rather than information about their health. | O | O | O | O | O | O |
| 11. | If a physiotherapist's primary tools are being open and warm, the physiotherapist will not have a lot of success. | O | O | O | O | O | O |
| 12. | When patients disagree with their physiotherapist, this is a sign that the physiotherapist does not have the patient's respect and trust. | O | O | O | O | O | O |
| 13. | A treatment plan cannot succeed if it is in conflict with a patient's lifestyle or values. | O | O | O | O | O | O |
| 14. | Most patients want to get in and out of the physiotherapist's office as quickly as possible. | O | O | O | O | O | O |
| 15. | The patient must always be aware that the physiotherapist is in charge | O | O | O | O | O | O |
| 16. | It is not that important to know a patient's culture and background in order to treat the person's illness. | O | O | O | O | O | O |
| 17. | Humor is a major ingredient in the physiotherapist's treatment of the patient. | O | O | O | O | O | O |
| 18. | When patients look up medical information on their own, this usually confuses more than it helps. | O | O | O | O | O | O |

## Comments welcome

# Appendix D: Education intervention used in the doctoral research project

The detail of the education intervention used in the doctoral research project presented in Chapters 5 and 6 is outlined in this Appendix.

Content of Pain Education Resource

Table 9.1

Content of Online Resource 1

| Topic | Information | Source |
|---|---|---|
| Pain vulnerability<br>*The influence of neuro-immune-endocrine plasticity across the lifespan* | Terms such as *acute pain* and *chronic pain* reinforce a simplistic tissue-based approach to pain that assumes the person with a new pain has a naive nervous system. Greater awareness of the **plasticity of the nervous system** directly challenges this (see Doidge 2007 for excellent introduction to this). However, if we are to take a more *sophisticated approach* to pain then we have to understand not just how the nervous system changes, but also how the **immune and endocrine systems** are influenced by prior life experiences.<br><br>Online Learning 1 will focus on current research and thinking on **pain vulnerability** that sets the scene for the use of the '*Pain and Movement Reasoning Model*'. Importantly, this Model promotes consideration of tissue factors, bio-mechanical factors and central modulating factors - the first two are pretty well understood by physiotherapists so the emphasis of the following resource is on integrating the central modulating factors into an understanding of pain. | LEJ notes |

| | | |
|---|---|---|
| Current concepts of pain | Understanding pain in less than 5 mins and what to about it | YouTube (Brainman channel) |
| | "...adverse life events by themselves did predict the onset of chronic multisite musculoskeletal pain..." | Generaal, E., Vogelzangs, N., Macfarlane, G. J., Geenen, R., Smit, J. H., de Geus, E. J., ... & Dekker, J. (2015). Biological stress systems, adverse life events and the onset of chronic multisite musculoskeletal pain: a 6-year cohort study. Annals of the Rheumatic Diseases, annrheumdis-2014-206741. |
| Immune and endocrine factors<br>*Pain as part of the Body's Protection System* | Note in the video above, the recommendation to look at the deeper things happening in life at the time of pain onset. The term **allostatic load** has been used to described the cumulative stressors - physical and psychosocial - that a system might need to adapt to. This could be relevant when we are thinking about the stressors faced by people who are hospitalised, undergoing surgery or experiencing other *non-pain related stress* (Hannibal et al, 2014).<br><br>"In clinical practice, allostatic load would seem important to consider, not just with presentations of chronic or persistent symptoms which | LEJ notes |

| | | |
|---|---|---|
| | invariably have complex psychosocial history, but also when considering acute presentations. The increased presence of stress and immune mediators may amplify sensitivity of the nervous system and promote a heightened vigilance and response to symptoms that may be out of proportion to the state of the tissues (Watkins and Maier, 2002, Grace et al., 2014). Importantly, allostatic load should not be seen as a pathological state, but an increased allostatic load may **prime the body's protection system** for an enhanced or a dysregulated stress response (Grace et al., 2014, Ganzel et al., 2010)." | EXCERPT from Jones, L.E. (2017) 'Stress, pain and recovery: neuro-immune-endocrine interactions and clinical practice'. In S. Porter Psychologically Informed Physiotherapy, Elsevier. |
| | QUOTE: "Glia and immune cells exert their influence on neural pain processing circuitry...for months after injury..." | Grace, P. M., Hutchinson, M. R., Maier, S. F., & Watkins, L. R. (2014). Pathological pain and the neuroimmune interface. Nature Reviews Immunology, 14(4), 217-231. |
| Consider broad factors even in acute injury<br>*Previous experience and distress* | QUOTE: "Pain is always complex but sometimes it presents simply." | Lester Jones |

| | | |
|---|---|---|
| | “Pain is it all in your mind”<br>Watch video from 06:15 to 10:17 | YouTube TEDx |
| Previous Adverse Experiences Prime the Body’s Protection System | QUOTE "Patients do not present with a naive nervous system" | Lester Jones |
| | “Why things hurt”<br>Watch video from 0:27 to 5:16 | YouTube TEDx |
| | QUOTE: "...if we keep running the neurons...they get better at producing pain." | Lorimer Moseley TEDx Adelaide |
| | [image] | Denk F. et al., (2014) Pain vulnerability, Nature Neuroscience Fig. 1 p193 |
| | ‘The drug cabinet in the brain’<br>Areas of the brain interact to 'decide' if it is worth having pain | |
| | QUOTE: "Knowledge is the greatest pain liberator of all." | David Butler The Drug Cabinet in the Brain |
| | So this is the end of ONLINE LEARNING RESOURCE 1. | LEJ notes |

Before the face to face session, ensure that you spend some time thinking about how these concepts fit into your physiotherapy practice - are they well established, are you developing confidence or are these foreign to you?

- pain vulnerability
- current concepts of pain
- immune/endocrine factors
- consider broad factors even in acute injury
- prior experiences prime the body's protection system

QUOTE: "Only recently have we fully appreciated that the classically separated domains of neurology, endocrinology, immunology and microbiology, with their various organs - the brain, glands, gut, immune cells and microbiota, could actually be joined to each other in a multidirectional network of communication, in order to maintain homeostasis."

El Aidy, S., Dinan, T. G. & Cryan, J. F. 2014. Immune modulation of the brain-gut-microbe axis. Frontiers in Microbiology, 5.

Table 9.2

Content of Online Resource 2

| Topic | Information | Source |
|---|---|---|
| Applying the Pain and Movement Reasoning Model<br>*Case examples of use at first contact, when client is in flareup and as patient education tool* | The following cases will help you to think of ways of integrating the Pain and Movement Reasoning Model into your clinical reasoning and your clinical practice.<br><br>The first case is supported by a detailed summary of how I have used the Model in the assessment and treatment process in a private clinic setting. The second case is a briefer summary of an example of using the Model to explain variation in pain. And the third case is an interesting story from a time I used the Model to structure a pain education session.<br><br>The final part of this section includes the Pain Reasoning Record which I hope you can complete as the final part of your education for this project. It is important to try to apply new knowledge and the template should provide some simple prompts. I will also collect these from you and analyse them as part of the research I am doing into the use of the Model. | LEJ notes |

| | | |
|---|---|---|
| CASE 1 – primary contact | The detailed information describes the importance of understanding the interaction of neuro-immune-endocrine factors and pain and the need to integrate these into your reasoning process.<br><br>In your clinical area of practice, do you have a strategy for capturing this complexity already? What are the advantages or disadvantages of using the Model as part of a primary contact process? | LEJ notes |
| 30 year old woman with neck and arm pain (Second level) | Using the Pain and Movement Reasoning Model I assess for central modulating factors first so that I am better placed to estimate the baseline sensitivity of the body's protection system.<br><br>Also during the interview, I am listening for evidence of tissue damage that is for local stimulation of nociceptors (chemical or mechanical) - or contexts that might be perceived as threatening.<br><br>Moving on to physical examination, I explore the local area and also regional contributors to the person's pain. In the following case, the cervicoscapular muscles and their attachments into cervical spine were a focus. | LEJ notes<br><br>References<br><br>Bartell J (2013) Dark days but the sun still shines. Available at http://www.theage.com.au/afl/afl-news/dark-days-but-the-sun-still-shines-in-flat-town-20130624-2osqn.html<br><br>Bialosky JE, Bishop MD, Price DD, Robinson ME, & George SZ (2009) The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. Manual Therapy, 14(5), 531-538. |

I always palpate the cervical spine in side lying which reflects my emphasis on a movement-centric approach and usually start by gently depressing and rotating the scapula and noting which muscles resist the movement. I have found that palpating the identified muscles to their cervical attachment often identifies the location of most cervical sensitivity.

Key Findings:

Interview

Woman presented at three weeks with right sided neck pain.

Works as practice manager in a dental practice. Mostly this role involved sitting in front of a computer and using a mouse in her dominant right hand.

Hurt her neck lifting and moving furniture after renovations at the business where she works. Unrelated to her normal role and found the renovation process, negotiating with tradesmen and the general disruption it caused, very stressful.


Deyo RA (2013) Real help and red herrings in spinal imaging. The New England Journal of Medicine, 368(11), 1056.

Guthrie B (2014) I was scared: Fasolo opens up about Anzac Day injury. Available athttp://www.afl.com.au/news/2014-05-24/i-was-scared-fasolo

Herald-Sun (2015) The VFL/AFL players who pushed through the pain barrier. Available athttp://www.heraldsun.com.au/sport/afl/the-vflafl-players-who-pushed-through-the-pain-barrier/story-fnp04d70-1227386290855

Jones LE & O'Shaughnessy DF (2014) The Pain and Movement Reasoning Model: Introduction to a simple tool for integrated pain assessment.Manual Therapy, 19(3), 270-276.

Moseley GL & Flor H (2012) Targeting cortical representations in the treatment of chronic pain a review. Neurorehabilitation and neural repair, 26(6), 646-652.

Tracey I & Mantyh, PW (2007) The cerebral signature for pain perception and its modulation. Neuron, 55(3), 377-391.

Only noticed pain (neck and right shoulder) the next day and she began restricting her movement to avoid provoking the pain and adopting antalgic postures supporting and resting right arm.

By three weeks the pain was spreading down her arm and into her hand but no sensory or motor changes reported.

She had not taken any days off but felt the pain was starting to impact. This interference was the motivator to seek advice and treatment.

She had not had any imaging which might be a good thing as it can increase perceived threat (Deyo, 2011).

Past medical history included several episodes of neck and back pain that all resolved and chronic ulcerative colitis which was mostly well controlled by medication. Most recent flare-up 6 months ago.

Social history included break-up of long term relationship five months ago.

Physical examination

Cervical rotation to the right was limited to ½ range due to ipsilateral symptoms in upper to mid cervical region.

Resistance to passive scapular movement demonstrated apparent tightness in both levator scapulae and report tender on palpation in both proximal and distal attachment with symptoms more pronounced on right.

Also tender through upper trapezius.

Formulation

In formulating the information from assessment I concluded that the woman's body protection system was activated in advance of the unusual physical exertion i.e. stress of renovation, past history of inflammatory condition, emotional breakup - and so her threshold to pain was likely reduced.

In this sensitised state she has engaged in novel high intensity lifting activity for which her body was not conditioned. It would seem the cervicoscapular muscles including insertions into cervical spine are contributing nociceptive input. These muscles would have been

excessively activated as she fatigued during the unusual lifting and moving tasks.

It could be argued her pain is reflective of cervical radiculopathy especially with the subsequent referral down her right upper limb. However my interpretation was influenced by the pre-existing sensitivity and the lack of clear sensory or motor deficiency.

It could be that the development of symptoms were delayed-onset muscle soreness-like, overlaid on a sensitised nervous system. Her subsequent reaction to this was to protect and guard the painful arm. This over-protection can lead to overactivity in muscles, reduced blood flow through tissues, hypervigilance for anything that might threaten the area and the amplification and referral of symptoms.

See representation on Pain and Movement Reasoning Model

Treatment

Treatment consisted of education about the multi-dimensions of pain and reassurance that there did not appear to be any serious tissue pathology.

It was reinforced that pain is predominantly a warning sign and not a reliable sign of tissue damage.

It was also explained the stress she was experiencing leading up to the lifting event meant she was predisposed to detect early warnings of tissue threat or harm.

She felt this explanation was helpful to her understanding of her condition.

We negotiated treatment including manual therapy as a tool to facilitate movement and enhance body awareness in the area.

The right scapula was mobilised to relax and stretch cervicoscapular muscles.

Low grade mobilisations over articular pillar at mid-cervical levels were justified to reinforce dissociation of structures in central representations of the cervical spine (Moseley

and Flor, 2013) as well as potential central relaxation reflexes (Bialosky et al 2009).

A series of stretches and movements were constructed as a home/work program with the emphasis on low repetitions and high frequency throughout day to interfere with the compensatory postures that had developed.

I checked with her that she felt safe to complete the program and encouraged her to do the activities calmly and comfortably.

Progress

On review one week later the woman reported great improvement.

She had no longer any apparent restriction to right cervical rotation and her arm and hand symptoms had disappeared.

She no longer had any problems completing her work tasks.

She felt there was still some stiffness in her neck and scapular region and so treatment was directed at passive

stretches of her right levator scapulae and upper trapezius.

Pain education was reinforced and a review of home/work program completed, with no further plan for clinic-based treatment.

A follow-up phone call was made three weeks after discharge and the woman reported that she continued to do stretching and movement activities and had no return of her symptoms.

## In Conclusion

This case highlights the benefits of adopting a person centred approach to physiotherapy. It also reinforces the benefits of taking a multidimensional approach to all cases of pain report.

Pain is a warning of potential harm, not of damage to tissues. It is part of the body’s protection system so is modified by other stressors and threats to the body that may or may not be related to an injury.

| | | |
|---|---|---|
| | The Pain and Movement Reasoning Model provides a framework for integrating the biopsychosocial approach with current theories of pain science. | |
| Case 3 - audio/video transcript<br>*[Third level]* | This case is a 30 year old woman who was working as a practice manager for a dentist. She came to see me for neck and arm pain affecting her dominant side that had been worsening for 3 weeks. She attributed the pain to moving furniture at the office while carpets were being replaced. A purely tissue-based evaluation of her pain may have focused on a discogenic problem or other radiculopathy. However, using the three categories of the Pain and Movement Reasoning Model I was able to integrate some key aspects of her personal story to explain her pain more fully. We can see from the slide there was the recent distress of breaking up from a long term relationship, a history of a chronic inflammatory problem, evidence of guarding with movement and posture, and the stress of an antagonistic interaction with the carpet installers. All of these could have made her more 'vulnerable' to pain. Refer to the Denk et al article in your reading list. This would have enhanced her pain | LEJ notes |

| | | |
|---|---|---|
| | experience in response to the novel physical task that she was attributing her pain to. | |
| Case 2 - assessing pain flare-up | 35yo Accountant - long history of pain now flared up<br>Reasoning through this woman's pain flareup using the Model enabled her to be more sophisticated in analysing the potential causes.<br>Importantly she was less fearful to return to exercise and she could see there might be other explanations for her increase in pain.<br>Do you think there is a role for the use of the Model, in your area of clinical practice, to understand the changes that happen in a person's pain experience? | LEJ notes |
| [Second level] | Image and links only, no text | |
| Case 2 - audio/video transcript<br>[Third level] | Transcript<br>The second case is a 35 year old who I had been guiding through pain management for about 3 months and was doing well having returned to regular exercise including running 6 kilometres. She presented to the clinic with an exacerbation of her pain and was attributing this to exercise although, she reported no change in the routine she had sustained for several weeks. Using the Pain and | LEJ notes |

| | | |
|---|---|---|
| | Movement Reasoning Model we worked through the categories to see if there might have been other influences leading to her increase in pain. From the slide we can see that she reported that she had been unwell. This in itself can enhance an existing pain condition through the heightened activation of the immune system. Refer to the Grace et al article in your reading list for more on this. Her illness had forced her to take time off work at a time when she had an important deadline to meet - which I would interpret as an important non-pain related stress relevant to her increase in pain. See the article by Hannibal and Bishop that supports this. To try to meet her deadline she continued to work on the task on the couch at home. This took some hours and I suspect that her posture, typing on a laptop on the couch, was also a contributing factor to her subsequent flareup of symptoms. Importantly, this discussion with the client using the Pain and Movement Reasoning Model, attenuated the blame on her exercise routine and so she had the confidence to return to the things that she had found helpful including running. | |
| Case 3 – pain education | 58yo long history of back pain - using the Model in education | LEJ notes |

| | | |
|---|---|---|
| | Do you think that you could use the Model as a tool in pain education? What might be the advantages and disadvantages in your clinical area of practice? | |
| | Be aware that in a situation like this one there is the **potential to do harm** if you pursue questions about past psycho-social experiences without professional training or access to support. In this case the person felt safe enough to share their story once the education process had facilitated some self-reflection about the contributors to his persistent pain. | |
| [Second level] | Image and links only, no text | |
| Case 3 - audio/video transcript<br>[Third Level] | The final case is a 58 year old man who presented with back pain and an intolerance for sitting. This man had a science and engineering background and was frustrated that he had had no explanation for his persistent pain. In educating him about pain, I decided to use the Pain and Movement Reasoning Model - the scribblings from this discussion are represented on the slide. We talked about the role of adverse life events in influencing pain and I refer you to the article by Generaal et al. This clearly | LEJ notes |

| | | |
|---|---|---|
| | provoked some self-reflection and as he worked through this new understanding of pain he disclosed that he had had a difficult childhood. This included being bullied and feeling isolated. He shared that his best friend was his dog and noted that he still found it emotionally upsetting when he thinks about the day the dog died. To him this realisation that his pain might be linked to his persisting emotional reactivity to childhood events was an important step for his explanation of persistent pain. He stated that he felt his next step should be to work with a mental health professional to explore this issue. | |
| Pain Reasoning Record<br>*Applying and reinforcing your Pain Knowledge* | By now you should have been provided with an A5 pad with blank copies of the Pain Reasoning Record for you to complete. See link below for a reminder of what this looks like in colour! The completion of this Record is an important part of the project as it has both education benefits and benefits for understanding the use of the Model.<br><br>As part of the education intervention, the template should assist you apply and explore how the Pain and Movement Reasoning Model might assist your clinical reasoning. | LEJ notes |

This is a very important part of ensuring that new learning is consolidated.

We will collect the Pain Reasoning Records from you after a six week period - so whether you complete a few or the whole pad of 25, please keep your completed copies in the envelope provided, ready for collection. We anticipate that a good number to complete would be 4 per week and it is fine to complete multiple Records for a patient who is seen across the recording weeks - it might be interesting for you to see how things change.

Remember it is OK if the Model doesn't work for you and as researchers we are very interested in how people might modify labels or adapt the Model in other ways to suit their own practice. We hope to capture the variable reactions to the Model in the focus groups. Feel free to markup the Pain Reasoning Records with label changes or comment.

Please contact Lester Jones if you need further advice on how to complete the Pain Reasoning Record
jones.le@students.latrobe.edu.au

## Appendix E: Focus group and interview guide

The Guide used by the research assistant in the doctoral research project presented in Chapters 5 (Paper 1) and Chapter 6 (Paper 2) is reproduced in this Appendix.

LA TROBE UNIVERSITY

# Focus Group and Interview Guide

## As part of the research project:

## 'The utilisation of a clinical reasoning tool for pain'


Co-ordinating Principal Investigator:

Lester Jones
PhD Candidate
La Trobe University

Supervising Principal Investigators:

Associate Professor Lisa Amir &
Professor Stephen Kent
La Trobe University

The **Focus Groups** will be held at the end of the intervention. That is after three structured education sessions and then six weeks of application in the clinic. It will be important to try to capture some of the early responses to the *Pain and Movement Reasoning Model*, subsequent changes to practice and innovations in the use of the Model. Finally it will be important to hear from participants who are resistant to using it and the challenges participants have found with adopting the Model into clinical practice.

## Semi-structured approach to focus groups

### Initial response

What were your thoughts when you were first introduced to the Model in your education session?

In what ways did the Pain Reasoning Record Template assist or limit your application of the Model?

### Change in Practice/Novel Use

In what ways did considering the three categories of the Model change your clinical approach to patients with pain?

In the education sessions, there were three examples of using the Model – as a reasoning tool for a new patient, as a strategy for determining the influences on a change in symptoms and as a tool to assist pain education. Do you find that you used the Model in similar ways? Examples? What other ways did you use or apply the Model?

### Resistance to use/Challenges to Practice

We are aware that for some people it will not be helpful to incorporate the Model into their reasoning or clinical practice. If there is anyone who found that, what were the features of the Model or your practice that made it difficult or not relevant for you?

### Patient responses

During the period you have been using the Model there might have been responses or reactions by patients that could be attributed to the Model or how you applied it. Can anyone share a story that might reflect how patients have responded to the Model?

The **Interviews** will aim to explore the use of the Model by participants further and will focus on (a) using the Pain Reasoning Record template (b) novel or innovative applications, (c) transformative changes in practice and (d) capturing patient outcomes.

The interviewees will be invited based on their potential to contribute further to these four areas. The basis for this invitation will be the review of their completed Pain Reasoning Records and/or the responses to discussion in Focus Groups.

## Appendix F: Codebook used in the doctoral research project

The codebook developed and used in the doctoral research project presented in Chapters 5 (Paper 1) and Chapter 6 (Paper 2) is reproduced in this Appendix.

Codebook produced using NVIVO – Paper 1 and Paper 2

| Name | Description |
|---|---|
| PAPER 01 - Education package | Codes relevant to PAPER 1 |
| Accessibility to the resources | Participants reporting their experience of accessing the resources including any difficulties with technology and level of material presented |
| Adopting content into clinical practice | Participants describing how they used components or content of the education package to help patients |
| Content aligns with current practice | Participants reporting that the education package was, for the most part, not new and/or aligned with their current practice (this is seen to be a good thing especially if the PMRM is aligning - and not in conflict - with experienced clinicians' practice) |
| Content aligns with prior CPD (inc. NOI) | Participants reporting that the education package aligned with prior pain learning including than run by international experts (this is seen to be a good thing especially if the PMRM is aligning - and not in conflict - with profession-recognised offerings such as NOI's Explain Pain) |
| Continued access for ongoing reference | Participants describing that during the project it would be good to have continued access or where they describe examples of returning to the resources (Note providing a deadline for access to the resources was a strategy by researchers to motivate completion of online tasks) |
| Education package and PMRM facilitates discussion with colleagues | Participants describing how they engaged others in discussion about pain or patients using the components of the education package or the PMRM itself. |
| Education package supported use of PMRM | Participants reporting that the education package was helpful in preparing them and supporting their use of PMRM in practice |
| Education package valued by nonMSK | Participants not from a MSK background valuing the pain education offered |

| Name | Description |
| --- | --- |
| Education package was a good refresher | Participants who had prior knowledge but welcomed the education as a refresher of that prior knowledge |
| Education package was empowering | Participants describing that more confidence to try new ways of working or engage with pain education differently |
| Education package was flexible to learner needs | Participants describing how the components of the education package allowed them flexibility in engagement including preferences for online and face-to-face |
| Improved confidence in pain assessment | Participants reporting the education gave them more confidence to assess people with pai |
| Linking of concepts together which helps with complexity | Participants appreciating how the education package allowed links to be made between aspects of knowledge and practice, allowing better management of the complexity of pain |
| New knowledge and insights into pain science, clinical practice | Participants describing elements of the education package providing new knowledge or new insights into existing knowledge |
| Pain Reasoning Record layout and completion | Participants reporting on how they engaged with the Pain Reasoning Record including comments on the layout and issues relating to completing the template |
| Pain Reasoning Record promoted reflection | Participants describing how the requirement to record their clinical reasoning helped them reflect more or consolidated the concepts delivered in the education package. |
| PMRM categories and labels need explanation | Participants reporting specifically on some issues with the education given on the PMRM categories and labels (Note the researcher intent was to give participants permission to re-label and modify the tool - but this was resisted by those who wanted to do it the 'correct' way!) |

| Name | Description |
| --- | --- |
| Recommend PMRM for junior staff | Participants reporting that they can see a role - or have incorporated - the PMRM into their mentoring of junior physiotherapists |
| Recommend PMRM for those new to working with people with pain | Participants reporting that they can see a role for the PMRM in developing those new to working with pain. |
| Recommend PMRM for use by post-graduate students | Participants reporting that they can see a role - or have incorporated - the PMRM into their mentoring in post-graduate training of physiotherapists |
| Recommend PMRM for use by pre-registration students | Participants reporting that they can see a role - or have incorporated - the PMRM into their mentoring of undergraduate/preregistration learner physiotherapists |
| Recommending PMRM to other disciplines | Participants reporting that they can see a role - or have incorporated - the PMRM in developing a shared understanding with other disciplines |
| Responses to the face-to-face learning | Participants describing their experiences or responses to the face-to-face learning component of the education package |
| Suggestions on how to enhance of education package | Participants describing enhancements or modification and even cautions (avoid 'pain is in head') relating to the use of PMRM, especially for those who have not been exposed to some of the concepts before. |
| | |
| | |
| | |
| | |

| Name | Description |
| --- | --- |
| PAPER 02 - Applying PMRM | Codes relating to the application, reponse to and evaluation of PMRM in clinical practice |
| Applying PMRM in practice with specific context or patient example | Participants describing an actual application of the model with a patient or a specific clinical context or episode |
| Assuming PMRM is a tool for chronic or persistent pain | Participants describing utility of the PMRM based on a distinction between acute and chronic/persistent pain. |
| Clarifying limitations of discipline or own practice | Participants describing or implying how using the PMRM has identified limitations in physiotherapy or their clinical practice |
| Elements of PMRM categories not always easy to identify or quantify | Participants describing difficulties in accessing information to support what is contributing to each category (?confidence in clinical judgement) |
| Health care roles and service delivery that influence practice (person-centred) | Participants describing issues with professional roles and expectations and the process of health service delivery that might influence person centred care |
| Importance in addressing all three categories (person-centred) | Participants describing explicitly the need to address all categories or where they emphasise/prioritise elements of the central modulation category that demonstrates a more holistic approach to pain or where they explicitly stated it was not important to address all three. |
| Indication will use PMRM in the future | Participants either directly stating or intimating that they will use the PMRM in the future |
| Not person centred language | Participant describing patients by their condition (e.g. knee replacements) |
| Novel or innovative modification or application | Participants describing how they may have altered or adapted or shared the PMRM in novel or innovative ways |

| Name | Description |
| --- | --- |
| Patient responses to education involving PMRM | Participants describing the positive impact on patients of using the PMRM directly or indirectly in patient education |
| PMRM allows comparison of patients | Participants reporting the use or potential use of the PMRM in comparisons with current and previous patients |
| PMRM allows weighting of relative contributions | Participants describing the plotting or weighting of relative contributions of each category |
| PMRM application prevented by patient characteristics | Participants describing patient characteristics including cultural and health beliefs that would prevent them from applying the model |
| Challenge of readiness to change | Participants sharing concerns about applying PMRM to those who are not ready to adopt more sophisticated ways of thinking about their pain i.e. beyond pain = tissue damage. |
| Concern about ability of patients to understand | Participants anticipating patients will not be able to understand education or rationale of PMRM |
| Potential for negative response | Participants anticipating often a negative patient response to applying the model |
| PMRM as a dynamic tool for reasoning pain | Participants describing the use of the PMRM to capture pain as a dynamic experience |
| PMRM as a guide to patient education | Participants describing the use of PMRM or the barriers or difficulties in using PMRM for patient education |
| PMRM as a reflective tool | Participants describe how using the tool makes them (re)consider more factors in assessment of pain and explore more options in treatment of pain, how they have done things in the past and how they might use today's clinical impression in the future (e.g. if things do not go so well). |

| Name | Description |
| --- | --- |
| PMRM categories allows variation by clinician to educate patient (patient centred) | Participants describing how they varied patient education incorporating concepts or categories of PMRM in a person-centred way |
| PMRM promoted more sophisticated reasoning | Participants describing how they thought more deeply or in a more integrated way about assessment or treatment decisions and processes or where they included a category where previously they may have not. |
| Relevant in area of practice | Participants reporting on, or implying, the relevance of the PMRM to their practice, including not relevant, |
| Staff factors affecting use of PMRM | Participants describing factors relating to their work or their motivation that interfered with their use of the PMRM |
| Using PMRM changes behaviour | Participants reporting changes to their reasoning process and how they use or rate information from interview, reflective practice, assessment and treatment and their decision making and actions related to referring to other disciplines |
| Using PMRM reinforced existing behaviour | Participants describing how using the model enhanced or refreshed or reinforced (but did not change) their existing approach to clinical practice |
| Using the categories as a way of refining reasoning | Participants describing the categories as a helpful way to refine their current thinking about pain assessment |
| Research Methods | Codes related to research methods |
| Focus group as part of education package | Participants apparently coming to new conclusion or understandings during focus groups |

| Name | Description |
| --- | --- |
| Issues regarding research process | Participants reporting a range of difficulties with research from time frames, to recruitment, to access to education package |
| Recruitment of patients and caseload | Participants specific comments about difficult recruiting patients because of caseload |
| Recruitment of patients and language | Participants specific comments about difficult recruiting patients because of low competence in English |
| Recruitment of patients and limited contact | Participants specific comments about difficulty recruiting patients because of their limit contact over the study period |
| Recruitment of patients and motivation or safety | Participants specific comments about difficult recruiting patients because of the patient's motivation or issues of safety (e.g. suspicious about signing multi-page document) |

# Appendix G: Permissions for reproducing publications and figures

Permissions include:

Chapter 1

Figure 1.1 The evolution of the gate control theory

Figure 1.2 Influences on pain perception

Chapter 2

Book chapter – Stress, pain and recovery

Figure within book chapter - Stress regulating process from homeostasis to allostatic overload

Chapter 3

Book chapter – Labour Pain

Chapter 7

Published paper – Nipple pain associated with breastfeeding

WOLTERS KLUWER HEALTH, INC. LICENSE
TERMS AND CONDITIONS

Aug 26, 2020

---

This Agreement between 210 Clementi Road ("You") and Wolters Kluwer Health, Inc. ("Wolters Kluwer Health, Inc.") consists of your license details and the terms and conditions provided by Wolters Kluwer Health, Inc. and Copyright Clearance Center.

| | |
|---|---|
| License Number | 4887530620122 |
| License date | Aug 14, 2020 |
| Licensed Content Publisher | Wolters Kluwer Health, Inc. |
| Licensed Content Publication | Pain |
| Licensed Content Title | From the gate to the neuromatrix |
| Licensed Content Author | Ronald Melzack |
| Licensed Content Date | Aug 1, 1999 |
| Licensed Content Volume | 82 |
| Type of Use | Dissertation/Thesis |
| Requestor type | University/College |
| Sponsorship | No Sponsorship |
| Format | Electronic |

| | |
|---|---|
| Will this be posted on a password protected website? | No |
| Portion | Figures/tables/illustrations |
| Number of figures/tables/illustrations | 1 |
| Author of this Wolters Kluwer article | No |
| Will you be translating? | No |
| Intend to modify/adapt the content | No |
| Title | Pain and Movement Reasoning Model |
| Institution name | La Trobe University |
| Expected presentation date | Sep 2020 |
| Portions | Figure 1 in From the gate to the neuromatrix. In particular I want to reproduce 'B' "An early development that led to the gate control theory..." |
| Requestor Location | 210 Clementi Road<br>10 Dover Drive<br><br>Singapore, 138683<br>Singapore<br>Attn: 210 Clementi Road |
| Billing Type | Invoice |
| Billing Address | 210 Clementi Road<br>10 Dover Drive |

Singapore, Singapore 138683
Attn: 210 Clementi Road

Total 0.00 AUD

Terms and Conditions

**Wolters Kluwer Health Inc. Terms and Conditions**

1. **Duration of License:** Permission is granted for a one time use only. Rights herein do not apply to future reproductions, editions, revisions, or other derivative works. This permission shall be effective as of the date of execution by the parties for the maximum period of 12 months and should be renewed after the term expires.
    i. When content is to be republished in a book or journal the validity of this agreement should be the life of the book edition or journal issue.
    ii. When content is licensed for use on a website, internet, intranet, or any publicly accessible site (not including a journal or book), you agree to remove the material from such site after 12 months, or request to renew your permission license
2. **Credit Line:** A credit line must be prominently placed and include: For book content: the author(s), title of book, edition, copyright holder, year of publication; For journal content: the author(s), titles of article, title of journal, volume number, issue number, inclusive pages and website URL to the journal page; If a journal is published by a learned society the credit line must include the details of that society.
3. **Warranties:** The requestor warrants that the material shall not be used in any manner which may be considered derogatory to the title, content, authors of the material, or to Wolters Kluwer Health, Inc.
4. **Indemnity:** You hereby indemnify and hold harmless Wolters Kluwer Health, Inc. and its respective officers, directors, employees and agents, from and against any and all claims, costs, proceeding or demands arising out of your unauthorized use of the Licensed Material
5. **Geographical Scope:** Permission granted is non-exclusive and is valid throughout the world in the English language and the languages specified in the license.
6. **Copy of Content:** Wolters Kluwer Health, Inc. cannot supply the requestor with the original artwork, high-resolution images, electronic files or a clean copy of content.
7. **Validity:** Permission is valid if the borrowed material is original to a Wolters Kluwer Health, Inc. imprint (J.B Lippincott, Lippincott-Raven Publishers, Williams & Wilkins, Lea & Febiger, Harwal, Rapid Science, Little Brown & Company, Harper & Row Medical, American Journal of Nursing Co, and Urban & Schwarzenberg - English Language, Raven Press, Paul Hoeber, Springhouse, Ovid), and the Anatomical Chart Company
8. **Third Party Material:** This permission does not apply to content that is credited to publications other than Wolters Kluwer Health, Inc. or its Societies. For images credited to non-Wolters Kluwer Health, Inc. books or journals, you must obtain permission from the source referenced in the figure or table legend or credit line before making any use of the image(s), table(s) or other content.
9. **Adaptations:** Adaptations are protected by copyright. For images that have been adapted, permission must be sought from the rightsholder of the original material and the rightsholder of the adapted material.

10. **Modifications:** Wolters Kluwer Health, Inc. material is not permitted to be modified or adapted without written approval from Wolters Kluwer Health, Inc. with the exception of text size or color. The adaptation should be credited as follows: Adapted with permission from Wolters Kluwer Health, Inc.: [the author(s), title of book, edition, copyright holder, year of publication] or [the author(s), titles of article, title of journal, volume number, issue number, inclusive pages and website URL to the journal page].
11. **Full Text Articles:** Republication of full articles in English is prohibited.
12. **Branding and Marketing:** No drug name, trade name, drug logo, or trade logo can be included on the same page as material borrowed from *Diseases of the Colon & Rectum, Plastic Reconstructive Surgery, Obstetrics & Gynecology (The Green Journal), Critical Care Medicine, Pediatric Critical Care Medicine, the American Heart Association publications and the American Academy of Neurology publications.*
13. **Open Access:** Unless you are publishing content under the same Creative Commons license, the following statement must be added when reprinting material in Open Access journals: "The Creative Commons license does not apply to this content. Use of the material in any format is prohibited without written permission from the publisher, Wolters Kluwer Health, Inc. Please contact permissions@lww.com for further information."
14. **Translations:** The following disclaimer must appear on all translated copies: Wolters Kluwer Health, Inc. and its Societies take no responsibility for the accuracy of the translation from the published English original and are not liable for any errors which may occur.
15. **Published Ahead of Print (PAP):** Articles in the PAP stage of publication can be cited using the online publication date and the unique DOI number.
    i. Disclaimer: Articles appearing in the PAP section have been peer-reviewed and accepted for publication in the relevant journal and posted online before print publication. Articles appearing as PAP may contain statements, opinions, and information that have errors in facts, figures, or interpretation. Any final changes in manuscripts will be made at the time of print publication and will be reflected in the final electronic version of the issue. Accordingly, Wolters Kluwer Health, Inc., the editors, authors and their respective employees are not responsible or liable for the use of any such inaccurate or misleading data, opinion or information contained in the articles in this section.
16. **Termination of Contract:** Wolters Kluwer Health, Inc. must be notified within 90 days of the original license date if you opt not to use the requested material.
17. **Waived Permission Fee:** Permission fees that have been waived are not subject to future waivers, including similar requests or renewing a license.
18. **Contingent on payment:** You may exercise these rights licensed immediately upon issuance of the license, however until full payment is received either by the publisher or our authorized vendor, this license is not valid. If full payment is not received on a timely basis, then any license preliminarily granted shall be deemed automatically revoked and shall be void as if never granted. Further, in the event that you breach any of these terms and conditions or any of Wolters Kluwer Health, Inc.'s other billing and payment terms and conditions, the license is automatically revoked and shall be void as if never granted. Use of materials as described in a revoked license, as well as any use of the materials beyond the scope of an unrevoked license, may constitute copyright infringement and publisher reserves the right to take any and all action to protect its copyright in the materials.
19. **STM Signatories Only:** Any permission granted for a particular edition will apply to subsequent editions and for editions in other languages, provided such editions are for the work as a whole in situ and do not involve the separate exploitation of the permitted illustrations or excerpts. Please view: STM Permissions Guidelines

20. **Warranties and Obligations:** LICENSOR further represents and warrants that, to the best of its knowledge and belief, LICENSEE's contemplated use of the Content as represented to LICENSOR does not infringe any valid rights to any third party.
21. **Breach:** If LICENSEE fails to comply with any provisions of this agreement, LICENSOR may serve written notice of breach of LICENSEE and, unless such breach is fully cured within fifteen (15) days from the receipt of notice by LICENSEE, LICENSOR may thereupon, at its option, serve notice of cancellation on LICENSEE, whereupon this Agreement shall immediately terminate.
22. **Assignment:** License conveyed hereunder by the LICENSOR shall not be assigned or granted in any manner conveyed to any third party by the LICENSEE without the consent in writing to the LICENSOR.
23. **Governing Law:** The laws of The State of New York shall govern interpretation of this Agreement and all rights and liabilities arising hereunder.
24. **Unlawful:** If any provision of this Agreement shall be found unlawful or otherwise legally unenforceable, all other conditions and provisions of this Agreement shall remain in full force and effect.

**For Copyright Clearance Center / RightsLink Only:**

1. **Service Description for Content Services:** Subject to these terms of use, any terms set forth on the particular order, and payment of the applicable fee, you may make the following uses of the ordered materials:
    i. **Content Rental:** You may access and view a single electronic copy of the materials ordered for the time period designated at the time the order is placed. Access to the materials will be provided through a dedicated content viewer or other portal, and access will be discontinued upon expiration of the designated time period. An order for Content Rental does not include any rights to print, download, save, create additional copies, to distribute or to reuse in any way the full text or parts of the materials.
    ii. **Content Purchase:** You may access and download a single electronic copy of the materials ordered. Copies will be provided by email or by such other means as publisher may make available from time to time. An order for Content Purchase does not include any rights to create additional copies or to distribute copies of the materials

**Other Terms and Conditions:**

v1.18

**Questions? customercare@copyright.com or +1-855-239-3415 (toll free in the US) or +1-978-646-2777.**

**From:** no-reply@copyright.com
**To:** Lester Edmund Jones
**Subject:** RESPONSE REQUIRED for Your Request to John Wiley & Sons - Books
**Date:** Tuesday, September 29, 2020 3:33:05 AM

**CAUTION:** This email originated from outside of SIT. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Dear Mr. Lester Jones,

John Wiley & Sons - Books has approved your recent request. Before you can use this content, you must accept the license fee and terms set by the publisher.

Use this link to accept (or decline) the publisher's fee and terms for this order.

**Request Summary:**
Submit date: 27-Sep-2020
Request ID: 600024830
Title: Recent Advances in Physiotherapy
Type of Use: Republish in other published product

Please do not reply to this message.

To speak with a Customer Service Representative, call +1-855-239-3415 toll free or +1-978-646-2600 (24 hours a day), or email your questions and comments to support@copyright.com.

Sincerely,

Copyright Clearance Center

Tel: 1-855-239-3415 / +1-978-646-2600
support@copyright.com
Manage Account

This message (including attachments) is confidential, unless marked otherwise. It is intended for the addressee(s) only. If you are not an intended recipient, please delete it without further distribution and reply to the sender that you have received the message in error.

**From:** no-reply@copyright.com
**To:** Lester Edmund Jones
**Subject:** Thank You for Your Order on Marketplace™
**Date:** Tuesday, September 29, 2020 9:04:31 AM

---

**CAUTION:** This email originated from outside of SIT. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Dear Lester Jones,

Thank you for placing your order on Marketplace™.

**Order Summary:**
Order date: 28 Sep 2020
Order number: 1066400
No. of items: 1
Order total: 0.00 AUD

**Billing Summary:**
Payment method: Invoice
An invoice will be generated and emailed within 24 hours.

To view your order details, click the following link, sign in, and search for your order: Manage Account.

How was your experience? Click here to give us feedback

Please do not reply to this message.

To speak with a Customer Service Representative, call +1-855-239-3415 toll free or +1-978-646-2600 (24 hours a day), or email your questions and comments to support@copyright.com.

Sincerely,

The CCC Marketplace Team

Tel: 1-855-239-3415 / +1-978-646-2600
support@copyright.com
Manage Account

This message (including attachments) is confidential, unless marked otherwise. It is intended for the addressee(s) only. If you are not an intended recipient, please delete it without further distribution and reply to the sender that you have received the message in error.

Reply Delete Junk Block ···

## FW: Obtain permission request - Book (1012231)

Post/Zip Code: 138683
City: Singapore
State/Territory:
Country: Singapore
Telephone:
Email: Lester.Jones@singaporetech.edu.sg

**Type of Publication:** Book

Title: Psychologically Informed Physiotherapy
ISBN: 9780702068171
Auhtors: Lester E. Jones
Year: 2017
From page: 78
To page: 106
Chapter number: 5
Chapter title: Stress pain and recovery
**I would like to use:** Full article / chapter

I am the author of the Elsevier material: Yes

In what format will you use the material: Print and Electronic
Translation: No

**Proposed use:** Reuse in a thesis/dissertation

**Additional Comments / Information:** Is it possible to have a pdf version of published chapter to allow easy compilation into thesis?

---

Notice: This e-mail may contain confidential and/or privileged information. If you are not the intended recipient or have received this e-mail in error, please notify the sender immediately and destroy this e-mail. Any unauthorized copying, disclosure or distribution of the material in this e-mail is strictly forbidden.
Singapore Institute of Technology, Co. Reg. No. 200917667D.

Reply | Forward

Reply Delete Junk Block ···

# FW: Obtain permission request - Book (1012231)

ELSEVIER

Dear Mr Lester Jones

We hereby grant you permission to reprint the aforementioned material at no charge **in your thesis, in print and on the University web site** subject to the following conditions:

1. If any part of the material to be used (for example, figures) has appeared in our publication with credit or acknowledgement to another source, permission must also be sought from that source. If such permission is not obtained then that material may not be included in your publication/copies.

2. Suitable acknowledgment to the source must be made, either as a footnote or in a reference list at the end of your publication, as follows:

   "This article was published in Publication title, Vol number, Author(s), Title of article, Page Nos, Copyright Elsevier (or appropriate Society name) (Year)."

3. Your thesis may be submitted to your institution in either print or electronic form.

4. Reproduction of this material is confined to the purpose for which permission is hereby given.

5. This permission is granted for non-exclusive world **English** rights only. For other languages please reapply separately for each one required. Permission excludes use in an electronic form other than as specified above. Should you have a specific electronic project in mind please reapply for permission.

6. Should your thesis be published commercially, please reapply for permission.

Kind Regards
Anita

**Anita Mercy**
Senior Copyrights Coordinator – Copyrights Team
Elsevier | Health Content Operations
(A division of Reed Elsevier India Pvt. Ltd.)
Ascendas International Tech Park, Crest – 12th Floor|Taramani, Chennai 600113 • India|
Tel: +91 4442994696
a.vethakkan@elsevier.com

Permissions Helpdesk please visit - Permissions Helpdesk Support Center

Join the Elsevier Connect Community
www.elsevier.com
Twitter | Facebook | LinkedIn | Google+

Reply Delete Junk Block ···

# Fwd: Permission to reproduce figure...Industrial Health

LJ **Lester Jones**
Fri 28/08/2020 11:26 AM
**To:** LESTER JONES

---------- Forwarded message ---------
From: **Masaya Takahashi** <takaham@h.jniosh.johas.go.jp>
Date: Fri, 28 Aug 2020 at 08:46
Subject: Fwd: Permission to reproduce figure...Industrial Health
To: Lester Jones <lesterphysiotherapy@gmail.com>
Cc: <ihjim@h.jniosh.johas.go.jp>

Hello Lester,

Thank you for your notice.

We would like to grant permission to use the figure you are requesting below.

Good luck with your thesis!

Cordially, -Masaya, Ind Health

----- Original Message -----
From: Lester Jones <lesterphysiotherapy@gmail.com>
To: ihjim@h.jniosh.johas.go.jp
Cc: --
Date: 2020/08/22 16:31:09
Subject: Permission to reproduce figure...Industrial Health

Hi Masaya,

I wrote to you in 2016 seeking permission to use a figure from an article published in 'Industrial Health'.

The figure is Figure 1 Stress regulating process from homeostasis to allostatic overload and is in the following article in Industrial Health.
In Mauss, D., Jian, L. I., Schmidt, B., Angerer, P., & Jarczok, M. N. (2015). Measuring allostatic load in the workforce: a systematic review. *Industrial
Health*, *53*(1), 5.

SPRINGER NATURE LICENSE
TERMS AND CONDITIONS

Aug 26, 2020

---

This Agreement between 210 Clementi Road ("You") and Springer Nature ("Springer Nature") consists of your license details and the terms and conditions provided by Springer Nature and Copyright Clearance Center.

| | |
|---|---|
| License Number | 4823550682674 |
| License date | May 07, 2020 |
| Licensed Content Publisher | Springer Nature |
| Licensed Content Publication | Springer eBook |
| Licensed Content Title | Labour Pain |
| Licensed Content Author | Laura Whitburn, Lester Jones |
| Licensed Content Date | Jan 1, 2019 |
| Type of Use | Thesis/Dissertation |
| Requestor type | non-commercial (non-profit) |
| Format | print and electronic |
| Portion | full article/chapter |
| Will you be translating? | no |
| Circulation/distribution | 100 - 199 |

| | |
|---|---|
| Author of this Springer Nature content | yes |
| Title | Labour Pain |
| Institution name | La Trobe University |
| Expected presentation date | Aug 2020 |
| Requestor Location | Lester Jones<br>10 Dover Drive<br><br>Singapore, 138683<br>Singapore<br>Attn: Lester Jones |
| Total | 0.00 AUD |

Terms and Conditions

**Springer Nature Customer Service Centre GmbH**
**Terms and Conditions**

This agreement sets out the terms and conditions of the licence (the **Licence**) between you and **Springer Nature Customer Service Centre GmbH** (the **Licensor**). By clicking 'accept' and completing the transaction for the material (**Licensed Material**), you also confirm your acceptance of these terms and conditions.

**1. Grant of License**

**1. 1.** The Licensor grants you a personal, non-exclusive, non-transferable, world-wide licence to reproduce the Licensed Material for the purpose specified in your order only. Licences are granted for the specific use requested in the order and for no other use, subject to the conditions below.

**1. 2.** The Licensor warrants that it has, to the best of its knowledge, the rights to license reuse of the Licensed Material. However, you should ensure that the material you are requesting is original to the Licensor and does not carry the copyright of another entity (as credited in the published version).

**1. 3.** If the credit line on any part of the material you have requested indicates that it was reprinted or adapted with permission from another source, then you should also seek permission from that source to reuse the material.

**2. Scope of Licence**

**2. 1.** You may only use the Licensed Content in the manner and to the extent permitted by these Ts&Cs and any applicable laws.

**2. 2.** A separate licence may be required for any additional use of the Licensed Material, e.g. where a licence has been purchased for print only use, separate permission must be obtained for electronic re-use. Similarly, a licence is only valid in the language selected and does not apply for editions in other languages unless additional translation rights have been granted separately in the licence. Any content owned by third parties are expressly excluded from the licence.

**2. 3.** Similarly, rights for additional components such as custom editions and derivatives require additional permission and may be subject to an additional fee. Please apply to Journalpermissions@springernature.com/bookpermissions@springernature.com for these rights.

**2. 4.** Where permission has been granted **free of charge** for material in print, permission may also be granted for any electronic version of that work, provided that the material is incidental to your work as a whole and that the electronic version is essentially equivalent to, or substitutes for, the print version.

**2. 5.** An alternative scope of licence may apply to signatories of the STM Permissions Guidelines, as amended from time to time.

**3. Duration of Licence**

**3. 1.** A licence for is valid from the date of purchase ('Licence Date') at the end of the relevant period in the below table:

| Scope of Licence | Duration of Licence |
|---|---|
| Post on a website | 12 months |
| Presentations | 12 months |
| Books and journals | Lifetime of the edition in the language purchased |

**4. Acknowledgement**

**4. 1.** The Licensor's permission must be acknowledged next to the Licenced Material in print. In electronic form, this acknowledgement must be visible at the same time as the figures/tables/illustrations or abstract, and must be hyperlinked to the journal/book's homepage. Our required acknowledgement format is in the Appendix below.

**5. Restrictions on use**

**5. 1.** Use of the Licensed Material may be permitted for incidental promotional use and minor editing privileges e.g. minor adaptations of single figures, changes of format, colour and/or style where the adaptation is credited as set out in Appendix 1 below. Any other changes including but not limited to, cropping, adapting, omitting material that

affect the meaning, intention or moral rights of the author are strictly prohibited.

**5. 2.** You must not use any Licensed Material as part of any design or trademark.

**5. 3.** Licensed Material may be used in Open Access Publications (OAP) before publication by Springer Nature, but any Licensed Material must be removed from OAP sites prior to final publication.

**6. Ownership of Rights**

**6. 1.** Licensed Material remains the property of either Licensor or the relevant third party and any rights not explicitly granted herein are expressly reserved.

**7. Warranty**

IN NO EVENT SHALL LICENSOR BE LIABLE TO YOU OR ANY OTHER PARTY OR ANY OTHER PERSON OR FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL OR INDIRECT DAMAGES, HOWEVER CAUSED, ARISING OUT OF OR IN CONNECTION WITH THE DOWNLOADING, VIEWING OR USE OF THE MATERIALS REGARDLESS OF THE FORM OF ACTION, WHETHER FOR BREACH OF CONTRACT, BREACH OF WARRANTY, TORT, NEGLIGENCE, INFRINGEMENT OR OTHERWISE (INCLUDING, WITHOUT LIMITATION, DAMAGES BASED ON LOSS OF PROFITS, DATA, FILES, USE, BUSINESS OPPORTUNITY OR CLAIMS OF THIRD PARTIES), AND
WHETHER OR NOT THE PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THIS LIMITATION SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY PROVIDED HEREIN.

**8. Limitations**

**8. 1.** ***BOOKS ONLY:***Where **'reuse in a dissertation/thesis'** has been selected the following terms apply: Print rights of the final author's accepted manuscript (for clarity, NOT the published version) for up to 100 copies, electronic rights for use only on a personal website or institutional repository as defined by the Sherpa guideline (www.sherpa.ac.uk/romeo/).

**9. Termination and Cancellation**

**9. 1.** Licences will expire after the period shown in Clause 3 (above).

**9. 2.** Licensee reserves the right to terminate the Licence in the event that payment is not received in full or if there has been a breach of this agreement by you.

**Appendix 1 — Acknowledgements:**

**For Journal Content:**
Reprinted by permission from [**the Licensor**]: [**Journal Publisher** (e.g. Nature/Springer/Palgrave)] [**JOURNAL NAME**] [**REFERENCE CITATION** (Article name, Author(s) Name), [**COPYRIGHT**] (year of publication)

For **Advance Online Publication papers:**
Reprinted by permission from [**the Licensor**]: [**Journal Publisher** (e.g. Nature/Springer/Palgrave)] [**JOURNAL NAME**] [**REFERENCE CITATION** (Article name, Author(s) Name), [**COPYRIGHT**] (year of publication), advance online publication, day month year (doi: 10.1038/sj.[JOURNAL ACRONYM].)

**For Adaptations/Translations:**
Adapted/Translated by permission from [**the Licensor**]: [**Journal Publisher** (e.g. Nature/Springer/Palgrave)] [**JOURNAL NAME**] [**REFERENCE CITATION** (Article name, Author(s) Name), [**COPYRIGHT**] (year of publication)

**Note: For any republication from the British Journal of Cancer, the following credit line style applies:**

Reprinted/adapted/translated by permission from [**the Licensor**]: on behalf of Cancer Research UK: : [**Journal Publisher** (e.g. Nature/Springer/Palgrave)] [**JOURNAL NAME**] [**REFERENCE CITATION** (Article name, Author(s) Name), [**COPYRIGHT]** (year of publication)

For **Advance Online Publication** papers:
Reprinted by permission from The [**the Licensor**]: on behalf of Cancer Research UK: [**Journal Publisher** (e.g. Nature/Springer/Palgrave)] [**JOURNAL NAME**] [**REFERENCE CITATION** (Article name, Author(s) Name), [**COPYRIGHT**] (year of publication), advance online publication, day month year (doi: 10.1038/sj.[JOURNAL ACRONYM])

**For Book content:**
Reprinted/adapted by permission from [**the Licensor**]: [**Book Publisher** (e.g. Palgrave Macmillan, Springer etc) [**Book Title**] by [**Book author**(s)] [**COPYRIGHT**] (year of publication)

**Other Conditions**:

Version 1.2

**Questions? customercare@copyright.com or +1-855-239-3415 (toll free in the US) or +1-978-646-2777.**

RACGP

Royal Australian College *of* General Practitioners

Healthy Profession.
Healthy Australia.

10 June 2020

**RE: PERMISSION REQUEST**

Dear Lester,

Thank you for your request for permission to reproduce material originally published in Australian Family Physician for your PhD thesis.

Please ensure the following copyright statement is included:

**Reproduced with permission from The Royal Australian College of General Practitioners from: Amir LH, Jones LE, Buck ML. Nipple pain associated with breastfeeding: Incorporating current neurophysiology into clinical reasoning. Aust Fam Physician 2015;44(3):127–32. Available at www.racgp.org.au/afp/2015/march/nipple-pain-associated-with-breastfeeding-incorporating-current-neurophysiology-into-clinical-reasoning/**

Permission is granted subject to the following conditions:

1. The use of RACGP material must be accompanied by the copyright statement stated above.
2. Permission is granted for the use and reproduction in the current version only and is not for future revisions, future editions, or ancillaries or derivatives of any works. Permission must be requested on a case-by-case basis.
3. The RACGP's consent must be sought before making any alterations or adaptions to the table or figure. If granted (at the RACGP's discretion), you must indicate the material has been adapted with permission.
4. Text, layout and content must be reproduced in the English language.
5. The RACGP (along with its employees and agents) bears no liability (including for negligence) to you or any users of the content for any loss or damage, cost or other expense (consequential or otherwise) incurred in connection with such content for any reason whatsoever.

Kind regards,

Tammie Kishere

Administration Officer
Content & Communication | Membership