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Original article

Physiotherapists implicitly evaluate bending and lifting with a round back as dangerous

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ABSTRACT

Background: Beliefs can be assessed using explicit measures (e.g. questionnaires) that rely on information of which the person is 'aware' and willing to disclose. Conversely, implicit measures evaluate beliefs using computer-based tasks that allow reduced time for introspection thus reflecting 'automatic' associations. Thus far, physiotherapists' beliefs about back posture and safety have not been evaluated with implicit measures.
Objectives: (1) Evaluate implicit associations between bending lifting *back posture* (straight-back *vs* round-back) and *safety* (safe *vs* danger); (2) Explore correlations between implicit and explicit measures of beliefs towards vulnerability of the back.
Design: Exploratory cross-sectional quantitative study.
Methods: 47 musculoskeletal physiotherapists completed explicit measures of fear of movement (TSK-HC), back beliefs ($BackPAQ_{Danger}$) and beliefs related to bending and lifting back posture and safety (BSB). An Implicit Association Test (IAT) was used to assess implicit associations between (*i*) images of people bending/lifting with a 'round-back' or with a 'straight-back' posture, and (*ii*) words representing 'safety' and 'danger'. A one-sample *t*-test assessed the degree and direction of the sample's IAT score. Cohen's *d* provided an effect size of the estimated bias. Correlation between IAT and each explicit measure was assessed using Pearson's coefficient.
Results: The sample displayed an implicit association between 'round-back' and 'danger' ($\mu = 0.213$, 95% CI [0.075-0.350], $p = .003$), with an effect size magnitude of 0.45. There were fair to moderate correlations between IAT and BSB ($r = 0.320$, 95% CI [0.036-0.556], $p = .029$) and, IAT and $BackPAQ_{Danger}$ ($r = 0.413$, 95%CI [0.143-0.626], $p = .004$).
Conclusions: Physiotherapists displayed an implicit bias towards bending and lifting with a round-back as dangerous.

1. Introduction

Beliefs that the back is vulnerable, and requires protection are common among people with (Darlow et al., 2015; Bunzli et al., 2015) and without (Munigangaiah et al., 2016; Darlow et al., 2014a; Briggs et al., 2010; Gross et al., 2006) LBP. Encounters with health care clinicians such as physiotherapists, who provide advice about LBP, are thought to play a role in the development of such societal beliefs (Darlow et al., 2013). Several studies have investigated beliefs of clinicians towards LBP (Synnott et al., 2015; Darlow, 2016; Bishop et al., 2007; Coudeyre et al., 2006). Despite limited evidence (Dreischarf et al., 2016; Roffey et al., 2010; Bazrgari et al., 2007), clinicians share the view that 'improper' posture (e.g. round-back) while bending and lifting is dangerous for the back (Synnott et al., 2015; Stevens et al., 2016; Darlow et al., 2012; Nijs et al., 2013), and possibly one of the causes of LBP (Synnott et al., 2015; Stevens et al., 2016; Darlow et al., 2012; Nijs et al., 2013). Specifically, physiotherapists have self-reported a perception of the back as vulnerable and a belief that adopting straight-back postures is safest (Nolan et al., 2018). Physiotherapist' beliefs can strongly influence their advice to patients, potentially fuelling unhelpful protective and/or avoidance behaviours (Darlow et al., 2013; Darlow et al., 2012; Bishop et al., 2008; Vlaeyen and Linton, 2006; O'Sullivan et al., 2016). For example, Lakke et al. (2015) found that healthy adults' lifting capacity was significantly reduced when

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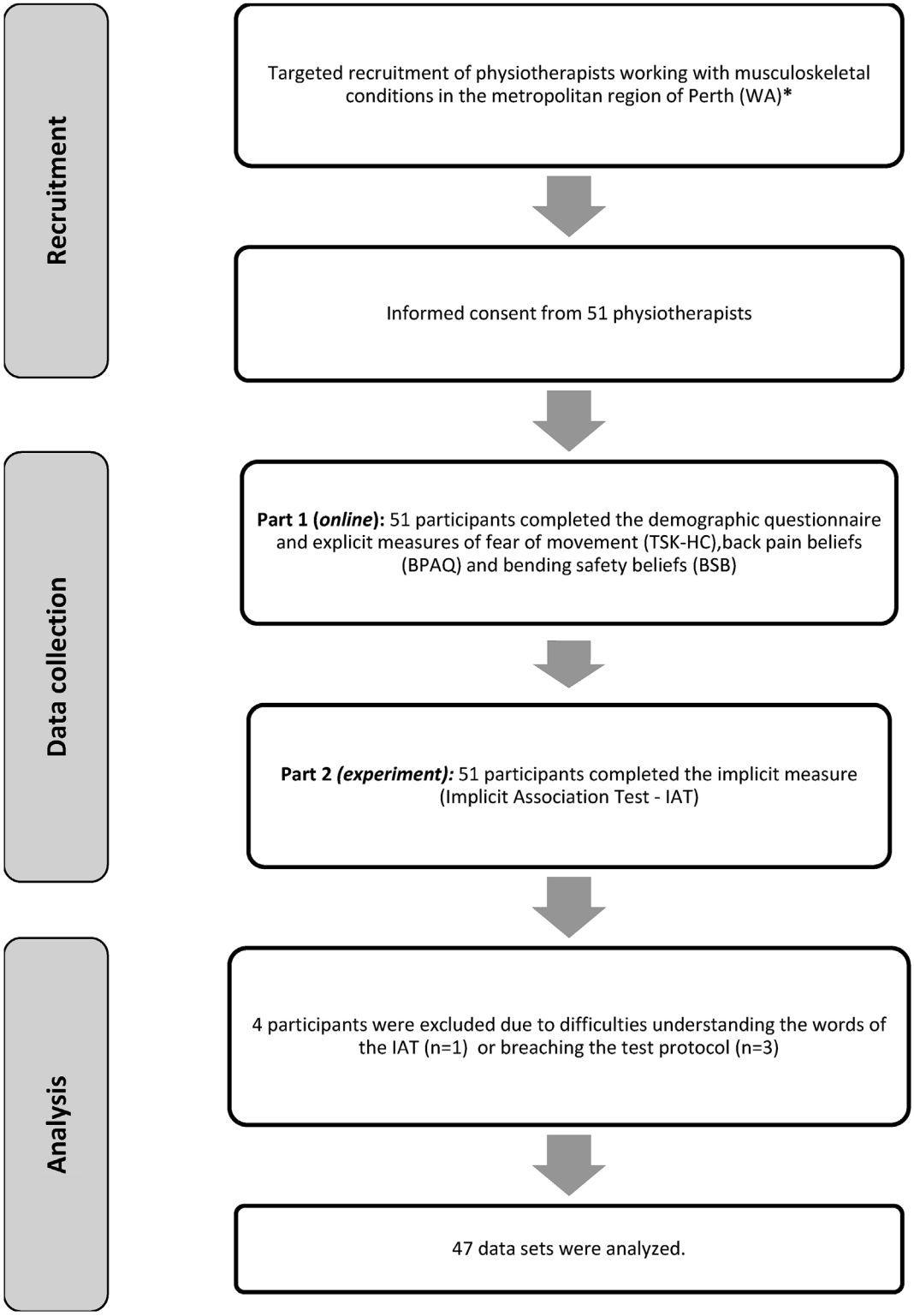

Fig. 1. Flow diagram outlining study procedure. *There are a total of 3475 Physiotherapists working in Western Australia, who hold a general registration with AHPRA. The number of Physiotherapists specifically working with musculoskeletal conditions is not available.

examined by physiotherapy students with high fear-avoidant beliefs (Lakke et al., 2015). Clinicians who hold such beliefs are also less likely to adopt evidence-based treatments (Coudeyre et al., 2006; Darlow et al., 2012). Not surprisingly, it has been proposed that disability associated with LBP may be in part iatrogenic (Darlow et al., 2013; Lin et al., 2013).

Beliefs can be assessed via explicit and implicit measures. Studies assessing beliefs of clinicians typically employed explicit measures (e.g. self-reported questionnaires (Darlow et al., 2014b; George et al., 2009; Houben et al., 2004)), which evaluate beliefs that are deliberately formed upon reflection. However, explicit measures are sensitive only to what people are aware of and are willing to disclose (Nosek et al., 2011; Fazio and Olson, 2003; Greenwald et al., 1998). Implicit measures on the other hand, assess beliefs based on 'automatic' associations

in memory (e.g. bending posture and danger). These associations can be assessed via computer-based reaction-time tests, which reduce the person's ability to control their response, minimizing effects of social desirability (Greenwald et al., 1998; Gawronski and Bodenhausen, 2006). The Implicit Association Test (IAT), is a well-validated and extensively used measure (Greenwald et al., 2003; Harvard, 2011), which requires the person to associate words or images as quickly and as accurately as possible (Greenwald et al., 1998; Van Ryckeghem et al., 2013). The speed with which the person performs the task reflects the strength of the associations, and can indicate the degree of implicit bias (Nosek et al., 2011). Depending on factors such as time and context (Nosek et al., 2011; Fazio and Olson, 2003; Greenwald et al., 1998), implicit biases can influence behaviour (Nosek et al., 2011; Greenwald et al., 2009; Sabin and Greenwald, 2012) in a manner that a person may not be aware of (Greenwald et al., 1998; Gawronski et al., 2006).

Considering physiotherapists often make clinical decisions under contexts of pressure (e.g. consultation time, patient's expectations and distress), an implicit bias may influence their advice to patients with LBP on bending and lifting posture (Houben et al., 2005a). Thus far, physiotherapists' implicit associations between back posture and safety have not been investigated. Based on studies assessing explicit beliefs about bending/lifting (Darlow et al., 2014a, 2015; Nolan et al., 2018), we hypothesised that i) physiotherapists would display an implicit bias towards evaluating bending and lifting with a round-back as dangerous, and ii) this bias would correlate only moderately with their explicit beliefs. Therefore, the aims were:

1) To evaluate implicit associations (IAT) between bending and lifting back posture (straight-back vs round-back) and safety (safe vs danger) in physiotherapists;
2) To explore correlations between implicit (IAT) and explicit measures of beliefs towards vulnerability of the back (bending safety beliefs, back beliefs, and fear of movement).

2. Materials & methods

2.1. Design

This was an exploratory cross-sectional quantitative study.

2.2. Participants and recruitment

This study used a sample of convenience. Potential participants were recruited in the period of April to June 2016 via email, phone call (to place of work) or approached in person by one of the investigators for participation in this study. Inclusion criteria: Physiotherapists, who were currently registered with the Australian Health Practitioners Registration Authority (AHPRA), practicing in the metropolitan area of Perth (Western Australia), and treating patients with musculoskeletal conditions. Exclusion criteria: Participants were excluded if they had difficulty to read and understand English. Informed consent was obtained upon agreement to participate. Ethics approval (HREC number: HRE2016-0192) was obtained from Curtin University's Health Science Human Research Ethics Committee.

2.3. Procedure

Participants were first invited to complete three questionnaires *online*. Thereafter, time was arranged with each participant to complete the *experiment* (IAT) at an agreed upon location, either at Curtin University or the participant's workplace. The study procedure is summarized in Fig. 1.

2.4. Demographic questionnaire

Participants' age, gender, years of practice, educational level, previous and current history, and management of LBP were recorded for sampling purposes only.

2.5. Outcome measures

This study employed an *implicit* measure of bending/lifting back posture and safety of the spine, and *explicit* measures of beliefs towards vulnerability of the back (bending safety beliefs, back beliefs, and fear of movement).

2.5.1. Implicit measure

2.5.1.1. Implicit association test (IAT). The IAT is a computer-based test that assesses strength of association between categories, indicating implicit biases (Greenwald et al., 1998; Harvard, 2011). The IAT (Nolan et al., 2018) is a well-established measure, which was adapted to assess associations between bending/lifting posture and safety in a group of people with back pain (Caneiro et al., 2017). The same IAT was used in this study, and included two categories of stimuli (either word or image). The *target categories* (images) were 'Round-back' and 'Straight-back' while the *attribute categories* (words) were 'Safe' and 'Danger'.

The words selected to represent the attribute category 'Safe' *were: harmless, certainty, protecting, confident, secure*; and 'Danger' *were: alarming, vulnerable, risky, damaging, threatening*. To represent the target categories, twelve (10) side view images of males and females bending

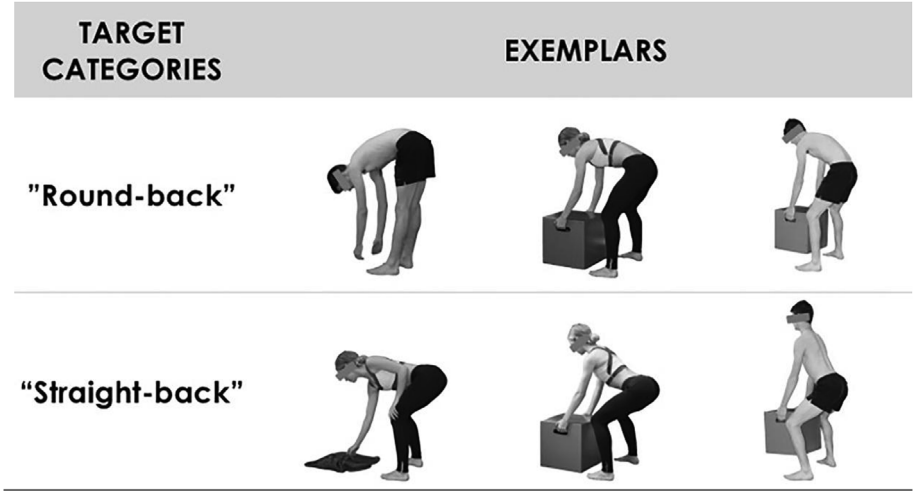

Fig. 2. Exemplars of the images developed to represent target categories in the IAT.

Table 1
Schematic representation of Implicit Association Test (IAT).

PHASE	TASK	SEQUENCE 1	
1	*Target-discrimination*	**Pictures**	
		Round-back	Straight-back
2	Attribute-discrimination	**Words**	
		Danger	Safe
3	Combined-discrimination_1	**Words/Pictures**	
		Danger/Round-back	Safe/Straight-back
4	Combined-discrimination_2	**Words/Pictures**	
		Danger/Round-back	Safe/Straight-back
5	Target-discrimination reversed	**Pictures**	
		Straight-back	Round-back
6	Combined-discrimination_3	**Words/Pictures**	
		Danger/Straight-back	Safe/Round-back
7	Combined-discrimination_4	**Words/Pictures**	
		Danger/Straight-back	Safe/Round-back

and lifting an object with a round back (target category 'Round-back') or with a straight back (target category 'Straight-back'), were created for this test (Fig. 2).

The IAT was set up on the researchers' laptops, allowing data collection at the physiotherapists' workplace. The words were presented in bold, 20-point Arial font in white lower case on a black background. The images were presented embedded in a white square frame of 450 × 440 pixels on a black background. Categories remained on screen throughout an entire phase.

2.5.2. Procedure

Instructions were provided on the screen prior to commencement of the experiment. The IAT consisted of 7 stages (Caneiro et al., 2017), (Table 1). For each stage, the participant was instructed to assign a stimulus (image/word displayed in the centre of the screen) to its suitable category (displayed in the left and right upper hand corner of the screen) by pressing the left or right "Shift" keys, as quickly as possible, while avoiding mistakes. Feedback ("correct" or "wrong") was provided to participants on each trial. In stage 1 (20 trials), participants sorted each of the 10 images twice, into the categories "Round-back" and "Straight-back". In stage 2 (20 trials), participants sorted the 10 words twice into the categories "Safe" and "Danger". In stages 3 and 4 (20 and 40 trials each) participants sorted words and images into the combined categories (e.g. Danger/Round-back and Safe/Straight-back). In stage 5 (20 trials) participants sorted images with the location of the categories switched. In stages 6 and 7 (30 and 40 trials each) the category combinations of phases three and four were reversed (e.g. Danger/Straight-back and Safe/Round-back). Half the participants were tested with the category combination (Danger/Round-back and Safe/Straight-back) first whereas the remaining saw the combinations (Danger/Straight-back and Safe/Round-back) first.

2.5.3. Data processing

Each trial started with the display of a fixation cross for 1000 ms followed by a word or image for 1000 ms and an inter-trial interval of 1000 ms. Presentation of the tasks and reaction time recording was controlled by DMDX (Dovidio and Fiske, 2012). Response time was defined as the time elapsed from the presentation of the word or image to when the left or right shift key was pressed. This time was recorded and incorrect responses, times shorter than 100 ms or longer than 1000 ms were considered as errors. A bias score ($IAT_{D\text{-score}}$) was calculated using the improved scoring algorithm recommended by Greenwald et al. (2003) (Moran et al., 2017) with an error penalty of 2 standard deviations. The $IAT_{D\text{-score}}$ is a standardised difference between response times during the two stages when danger is paired with round back versus the two stages when danger is paired with a straight back. The $IAT_{D\text{-score}}$ can therefore be either positive or negative, with zero indicating no implicit bias, a positive score indicating implicit bias towards a round-back posture as dangerous and a negative score indicating implicit bias towards a straight-back posture as dangerous. The IAT exhibits adequate reliability and, internal, construct and predictive validity (Gawronski et al., 2006; Caneiro et al., 2017; Moran et al., 2017).

2.5.4. Explicit measures

2.5.4.1. Bending safety belief (BSB). To assess specific beliefs related to bending and lifting back posture and safety of the spine, the BSB was developed. The BSB consists of a pictorial scale containing two images of a person bending forward and lifting a light object (e.g. shoe) – one with a round-back and one with a straight-back (Appendix). The participants were asked, "how would you rate the level of risk to this person's back?" for each image using a Likert scale (anchored on "0" meaning safe, and "10" meaning danger). A thermometer score ($BSB_{Thermometer}$) was derived to determine the participant's belief about safety of bending. The danger rating of the picture illustrating bending with a 'straight-back' was subtracted from the danger rating of the picture illustrating bending with a 'round-back'. In line with the implicit $IAT_{D\text{-score}}$, a positive value therefore indicated a higher danger rating for round-back than a straight-back and a negative score indicated higher danger rating for straight-back than a round-back. The BSB pictorial scale was developed based on the item "reaching to the floor" on the Fear of Daily Activities Questionnaire (George et al., 2009). The Fear of Daily Activities Questionnaire has been shown to have adequate internal consistency (Cronbach alpha = .91), and adequate reliability (intraclass correlation coefficient = 0.90) in determining fear of specific activities (George et al., 2009). The BSB pictorial scale has been used in another study (Caneiro et al., 2018).

2.5.4.2. Back pain attitudes questionnaire (Back-PAQ). The Back-PAQ was designed to assess back pain attitudes of the public, healthcare professionals, or those with back pain (Darlow et al., 2014b). The Back-PAQ consists of 34 items that assesses five key components including, but not limited to 'vulnerability and 'protection' of the back (Darlow et al., 2014b). Participants answered the items on a 5-point Likert scale from "false" to "true" (intermediate labels: 'Possibly False', 'Unsure', 'Possibly True). Scoring boundaries range from 34 to 170, with higher scores indicating more unhelpful beliefs about the back. The 34-item long form of the questionnaire has been shown to have acceptable internal consistency (α = 0.70; 95% CI 0.66 to 0.73), construct validity and test-retest reliability (Darlow et al., 2014b; Moran et al., 2017). For the purpose of this study, a subscale called 'danger scale' ($BackPAQ_{Danger}$) was formed by 14 items from the questionnaire (questions 1–12, 14 and 21), which are representative of 'vulnerability and 'protection' themes. These themes emerged from the qualitative study that the BackPAQ originated from Houben et al. (2004). The 'danger scale' score was assessed for correlation with other explicit and implicit scores.

2.5.4.3. Tampa scale of Kinesiophobia – health care clinicians (TSK-HC). The TSK was designed to measure fear of movement in patients, and it was previously modified by Houben et al. (2005a,b) (Moran et al., 2017) to measure concerns for movement that clinicians may have for their patients by rewording the items in order to target them at clinicians' beliefs (Houben et al., 2005a,b). For example, the item "*my* lower back pain would probably be relieved if *I* were to do exercises" was reworded to "*the* lower back pain would probably be relieved if *the patient* were to do exercises". The TSK-HC (Moran et al., 2017) consists of 17 items using a six-point Likert scale that ranges from 'totally agree' to 'totally disagree'. Scores range from 17 to 68, with a high score reflecting a strong concern for the possibility of physical movement being harmful (Houben et al., 2005a). Cronbach's alpha in the study by

Houben et al. (2004) (Houben et al., 2004) was 0.81, which showed high internal consistency.

2.6. Statistical analysis

Summary descriptive statistics were calculated for demographic data. For the measure of implicit bias ($IAT_{D\text{-}score}$), a one-sample *t*-test was used to assess the degree and direction of the deviation of the score from zero, with 95% confidence intervals used to interpret the size and precision of the estimate. Normality of the data was tested before the *t*-test was undertaken. Additionally, Cohen's *d* was calculated to provide a standardised effect size to assist in the interpretation of the size of the estimated bias (Sabin et al., 2008).

As for the $IAT_{D\text{-}score}$, a one-sample *t*-test was used to assess the degree and direction of the deviation of the $BSB_{Thermometer}$ score from zero. The correlation between the $IAT_{D\text{-}score}$ and each of the explicit measures ($BSB_{Thermometer}$, $BackPAQ_{Danger}$ and TSK-HC) was assessed using Pearson's correlation coefficient with associated 95% confidence intervals. For reporting of correlations, the magnitude of association was interpreted as: little or no relationship (from 0.00 to 0.25), fair to moderate relationship (from 0.25 to 0.50), moderate to good relationship (from 0.50 to 0.75), good to excellent relationship (above 0.75) (Portney and Watkins, 2015). An *a priori* power calculation estimated a sample of 50 participants would have 80% power to detect a standardised $IAT_{D\text{-}score}$ difference from 0 of ± 0.4 and correlations between implicit and explicit measures of ± 0.4 or greater (two-sided tests, $\alpha = 0.05$). SPSS version 24 statistical software was used for statistical analysis (IBM SPSS Statistics for Windows, version 24, IBM Corp., Armonk, N.Y., USA).

3. Results

3.1. Participants

Data was collected for 51 participants; four participants were excluded due to difficulties understanding the words of the IAT (1), or breaching the test protocol (3) – e.g. asking for instructions during the test, being disrupted during the test. Forty-seven data sets were included in the analysis, and there was no missing data for any of the participants. Participants' demographic characteristics are summarized in Table 2.

3.2. Implicit measure

The mean $IAT_{D\text{-}score}$ was 0.213 (SD = 0.470) and significantly larger than zero (p = .003, 95%CI [0.075-0.350], t(46) = 3.103), indicating a bias towards round-back being associated with danger in this group of physiotherapists currently treating musculoskeletal conditions. The magnitude of this estimated effect size as measured by Cohen's d was 0.45.

Table 2
Participants' Characteristics.

Characteristics	n (percentage)	Mean (SD (range))
Age	–	31.9 (6.6 (21–56))
Female	22 (46.8)	–
Male	25 (53.2)	–
Years as physiotherapist	–	7.9 (7.1 (1–35)
Physiotherapist	31 (66)	–
Postgraduate Physiotherapist	16 (34)	–
Present back pain	11 (23)	–
Previous history of back pain	20 (42)	–
Family history of back pain	26 (55)	–
Use of medication for back pain	15 (31)	–
Physical impairment from back pain	18 (38)	–
Use of management for back pain	26 (55)	–

3.3. Explicit measures

The mean $BSB_{Thermometer}$ score was −0.7 (SD = 3.6), which was not significantly different from zero (p = .193, 95%CI [-1.8–0.4], t(46) = -1.32). Analysis of the distribution of $BSB_{Thermometer}$ score across the sample revealed that 30% of the sample had a positive score indicating a higher danger rating for round-back than a straight-back as dangerous, 23% had score of zero, and 47% had a negative score indicating a higher danger rating for straight-back than a round-back as dangerous. The mean TSK-HC score was 30.3 (SD = 6.2) for fear of movement, and the mean BackPAQ score was 29.4 (SD = 15.7) for back beliefs with the subscale $BackPAQ_{Danger}$ having a mean of 31.4 (SD = 10.0).

3.4. Associations between implicit and explicit measures

There were fair to moderate significant correlations between the $IAT_{D\text{-}score}$ and the $BSB_{Thermometer}$ score (r = 0.320, 95% CI [0.036-0.556], p = .029) and between the $IAT_{D\text{-}score}$ and the $BackPAQ_{Danger}$ score (r = 0.413, 95% CI [0.143-0.626], p = .004). There was no correlation between the $IAT_{D\text{-}score}$ and TSK-HC (r = 0.231, 95% CI [−0.060-0.486], p = .119).

4. Discussion

This study aimed to evaluate physiotherapists' implicit associations between bending and lifting *back posture* (straight-back vs. round-back) and *safety* (safe vs. danger); and whether the implicit measure correlated with explicit measures of beliefs towards vulnerability of the back (bending safety beliefs, back beliefs, and fear of movement).

Our first hypothesis was supported. Results from the *implicit* measure (IAT), indicate that physiotherapists were faster to associate images of bending and lifting with a 'round-back' with words representing 'danger', rather than with words representing 'safety', meaning that this sample of physiotherapists displayed an implicit bias towards 'round-back' bending and lifting as dangerous for the back.

Our second hypothesis was only partially supported because only two of three explicit measures correlated moderately and significantly with the implicit measure. These correlations were between bending safety belief ($BSB_{Thermometer}$) and the $IAT_{D\text{-}score}$, and between LBP beliefs ($BackPAQ_{Danger}$) and the $IAT_{D\text{-}score}$, indicating some alignment of the constructs assessed by these measures. The magnitude of these correlations nonetheless indicates a level of mismatch between the reports in the different measures, and suggests that these measures may assess a common core construct, but distinct aspects of that construct. The three explicit measures have varying degrees of alignment to the specific construct that was assessed by the IAT. While the TSK-HC assesses fear of movement, none of its items relate to how a person moves or specifically, about the person's back posture during bending and lifting. In contrast, the $BackPAQ_{Danger}$ scale has specific questions about back posture, bending and lifting, and the BSB uses an image to ensure specificity of the construct assessed (bending posture and safety) (Leeuw et al., 2007a; Hofmann et al., 2005). In support of our results, a meta-analysis of correlations between explicit measures and the IAT across 126 studies in the field of social psychology suggested that the association between these measures is influenced by the conceptual correspondence of the constructs being assessed (Hoffman et al., 2007). In other words, the magnitude of the correlations is likely to differ depending on whether the questionnaire and the implicit measure target the same construct.

Our results are intriguing as they provide some indication that under a time-constraint *context*, physiotherapists may display associations in memory that are not entirely reflective of their self-reported beliefs. Considering the proposed role of implicit attitudes on a person's behaviour (Nosek et al., 2011; Greenwald et al., 2009; Dovidio and Fiske, 2012) such as the clinical choices physiotherapists make, our

results require further consideration. The following section will make sense of these results and reflect on the potential impact of this *implicit 'round-back/danger' bias* in physiotherapy practice.

Physiotherapy training in musculoskeletal pain has historically been largely based on a patho-anatomical and biomechanical paradigm (Synnott et al., 2015; Pincus et al., 2006). This includes amongst other factors, the ability to recognize patterns of posture and movement and its relationship with clinical presentations (e.g. lifting posture and LBP). With training and experience, these clinical profiles may be accessed with reduced deliberate thought for efficient decision-making (Chapman et al., 2013; Harman et al., 2009). In physiotherapy practice however, managing patient's beliefs, expectations and pain-related distress, while providing treatment under the time constraints of an appointment poses a significant challenge. In that *context*, reliance on automatic associations of clinical profiles (e.g. lifting posture and LBP) and treatment advice (e.g. protect the back) may influence the clinician's treatment behaviour unintendedly (Gawronski and Bodenhausen, 2006; Gawronski et al., 2006; Chapman et al., 2013). For instance, Houben et al. (2005a,b) investigated explicit and implicit attitudes (biomedical vs. biopsychosocial) of physiotherapy students on treatment recommendation for LBP (Houben et al., 2005a). The authors used three videos of different clinical contexts (1: examination of patient with back pain; 2: advice on activity or rest after a flare up of back pain; 3: advice on time-contingent vs pain-contingent approach after a flare up of back and leg pain) to which the students had one minute to provide treatment advice, creating time-pressure resembling clinical practice. The study reported that explicit biomedical attitudes were predictive of treatment advice by physiotherapy students in two videos, while implicit biomedical attitudes were predictive of biomedical treatment advice in one video. Their results suggest that both explicit and implicit attitudes can predict behaviour depending on the clinical context (Houben et al., 2005a).

It has been proposed that a person's behaviour may be the result of the interaction of implicit associations and deliberate reasoning on the situation at hand (Nosek et al., 2011; Fazio and Olson, 2003; Gawronski and Bodenhausen, 2006). The level to which this interaction influences a person's behaviour relates to several factors that form a *context*, including *motivation*, *opportunity*, *ability*, and *awareness* (Nosek et al., 2011; Fazio and Olson, 2003). In the context of physiotherapy practice for example, the clinician may have the knowledge and motivation to adopt an evidence-based biopsychosocial approach, however factors such as restricted consultation time (opportunity), experience and clinical reasoning level (ability), and beliefs (awareness of how one feels about a construct - e.g. round-back lifting is safe) may affect the clinician's advice in the consult. Although speculative, it is plausible that in certain *contexts*, the implicit 'round-back/danger bias' displayed by the physiotherapists in our study may have the potential to influence their recommendations in practice. For example, this may involve reinforcing prevailing beliefs in society that bending and lifting are dangerous and 'good' posture (e.g. straight-back posture) protects the back (Darlow et al., 2015; Darlow, 2016; Stevens et al., 2016). However, the extent to which physiotherapists' implicit bias influences clinical processes is not known (Houben et al., 2005a). Future research examining potential influences of this implicit 'round-back/danger bias' on clinical decision-making and physiotherapy advice for people with LBP, would be valuable.

4.1. Limitations

To the authors' knowledge, this is the first study to assess implicit attitudes of experienced physiotherapists, specifically related to bending and lifting safety. However, this study has some limitations. *First,* the authors acknowledge that no specific sampling frame was used and this was a sample of convenience. Consequently, this sample may not accurately reflect population characteristics in terms of factors that may potentially be associated with the degree of implicit bias, such as history of back pain or postgraduate training. However, the sample characteristics (presented in Table 2) demonstrate that this sample is a reasonable representation of the population of physiotherapists treating musculoskeletal conditions, and hence any sampling bias of the average level of $IAT_{D\text{-}score}$ in this population is likely to be small. *Second,* the use of a cohort from a single city could potentially reflect similar training backgrounds. However, demographics of this group indicate that physiotherapists with varied education level, years of experience and training background were included. *Third,* this study was not powered to investigate the relationship between factors such as physiotherapist's education level and history of back pain with an implicit bias. Such analysis could be a focus of future research. *Fourth,* the question used in the BSB is clinically relevant when assessing beliefs about bending, as it provides information whether there is a perception of danger in relation to the way a person bends. However, although this question was adapted from a validated questionnaire (George et al., 2009), and used in a previous study involving people with LBP (Caneiro et al., 2017), its psychometric properties have not been tested. *Fifth,* the reliability of implicit measures has been questioned in the past (Leeuw et al., 2007b). Although the IAT has adequate psychometric properties (Greenwald et al., 2003), the task used in this study was purposefully adapted to address a question of interest. Therefore, before firmer conclusions can be derived from this study replication of these findings is warranted.

5. Conclusion

The current study demonstrated that physiotherapists displayed an implicit bias to associate bending and lifting with a round-back with danger, while generally reporting mixed explicit beliefs about bending safety. There was some concordance between explicit and implicit measures of beliefs. Considering implicit attitudes may influence behaviour, future studies investigating whether this implicit 'round-back/danger bias' is associated with physiotherapist's clinical advice on bending and lifting posture for people with LBP are indicated.

Authors' contribution

JP Caneiro, Peter O'Sullivan, Anne Smith and Ottmar Lipp provided concept/idea/research design. Ingrid Ovrebekk, Luke Tozer, Michael Williams and Magdalene Teng performed data collection. JP Caneiro, Peter O'Sullivan, Ottmar Lipp, Anne Smith, Ingrid Ovrebekk, and Magdalene Teng provided data analysis. All authors contributed to discussion of results and writing of the manuscript (including review of manuscript before submission).

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Appendix

Figure - Images used for the bending and lifting safety beliefs thermometer score. The question, "how would you rate the level of risk to this person's back?" was displayed above each image, and a Likert scale (anchored on "0" meaning safe, and "10" meaning danger) was displayed bellow each image.

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