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Development and validation of the Physical Activity-Specific Rumination Scale for Children (PARSC) through understanding the intrinsic facilitators and barriers of physical activity in UK children – a mixed-method study.

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Abstract

Background: An increasing number of physical activity (PA) interventions have been implemented to tackle child obesity epidemic, yet many have shown only moderate effectiveness. This is possibly due to a lack of in-depth understanding of the intrinsic motivators/demotivators to PA for children. Therefore, a main aim of this paper is to explore the intrinsic facilitators and barriers to PA participation through the lived experience of UK children (Study 1). The latter findings will facilitate the development of a psychometric instrument that assesses children's tendencies to engage in repeated negative thoughts about PA (termed rumination) which may hinder participation. Hence, our second aim is to develop and validate the PA-specific Rumination Scale for Children (PARSC) (Study 2).

Methods: For Study 1, pedometry PA data were collected from 143 children (aged 6-10 years) over 3 weeks (Sample 1). Twenty-one focus groups were formed based on participants' year group, sex and PA level. Focus group discussions were thematically analysed. For Study 2, the themes identified for the intrinsic barriers were used to develop PARSC. This was completed twice by 382 children (Sample 2), together with the PA subscale of the Physical Self-Description Questionnaire (short version). Sample 1 also completed the avoidant coping subscales of the Children Coping Strategies Checklist.

Results: For Study 1, four overarching themes were identified for the intrinsic facilitators – sense of competence/accomplishments, cognitive motivator, sensations and socialisation/social facilitation. Four main themes for the intrinsic barriers were lack of competence, fear of negative experiences, external constraints and lacking a sense of purpose. For Study 2, results from Rasch analysis demonstrated that PARSC possessed sound internal validity and consistency, and test-retest reliability. Self-perceived PA and avoidant coping were predictive of PA-specific rumination tendencies (15% of variance explained), but objectively measured PA was not.

Conclusions: The themes identified from the current study can potentially inform future PA interventions and PE curriculum for UK children. Also, PARSC can be a useful tool to assess children's PA-specific rumination tendencies and to advance our understanding of the role of rumination in PA behaviour, but its applicability to other cultures warrants further investigations.

Background

In the past 4 decades, child obesity has become a global issue with an upward surge by more than tenfold, from 11 million in 1975 to 124 million in 2016 within the 5-19-year-old population[1]. In the UK, about a third of children aged 2–15 are overweight or obese[2], and the accompanying consequences are the development of cardiovascular diseases which are likely to be carried to adulthood if left untreated[3]. Recognising habitual physical activity (PA) to be one of the most modifiable lifestyle factors to curb the epidemic, the number of PA interventions has increased exponentially over the years, however, these initiatives have presented limited (long-term) effectiveness in increasing habitual PA or improving metabolic health status across intervention settings[4,5].

A possible reason for the lack of fruitfulness is that children were seldom involved in the design of these interventions, but it is based on researchers', education and/or health professionals' views on what intrinsically motivates, or hinders, children to participate in PA[6]. At best, the design of these initiatives was informed by self-report measures of PA determinants, and children's perspectives were confined by these pre-defined factors that might not be entirely reflective of their lived experiences[7]. Moreover, despite that many interventions were theory-driven as recommended by some researchers[8], a more thorough understanding of how theories and behaviour change determinants might apply to the target population is lacking. An example is the use of Social Learning Theory[9] to promote in-school moderate-vigorous PA (MVPA) in adolescent girls via a peer-led brisk walking programme[10]. The authors have offered a few explanations for the null findings, yet the possibility that the choice of role models selected by the researchers for the study might not be aspiring enough for the participants had not been recognised. In another school-based intervention informed by Self-Determination Theory[11], only one of the two intervention arms (free choice vs set choices) showed a significant increase on MVPA during PE lessons, hence not all levels of autonomy can achieve the same effect. In order to understand the nuances of how some PA determinants contribute to PA participation, it is crucial that we listen to the children's accounts of their lived experiences through which effective interventions can be designed.

In fact, very often the only time when children's voice is heard is in the process evaluation of an intervention[12,13]. It is not uncommon to receive positive feedback from the stakeholders about the intervention strategies, but the intervention primary outcomes often suggest otherwise[12,14]. The possible reason for this contradiction could be attributable to the novelty effect that biased participants' perception, but once the novelty had faded, adherence to the interventions became challenging leading to failure to achieve the expected changes. Thus, where possible, it is vital that children are involved in the intervention development process through understanding factors that intrinsically motivate or demotivate them to PA participation. To date, only few studies have explored the intrinsic facilitators and barriers of PA from children's perspectives[15,16], and none has been conducted with UK children, yet cultural relevance is pertinent in our understanding of health behaviours[17]. Therefore, a main aim of the current investigation (Study 1) is to explore the intrinsic motivators and barriers to PA participation through UK children's accounts of their lived experiences.

Additionally, through the intrinsic barriers, the negative thoughts about PA that might hinder children's participation can be better understood. The tendency to passively and repeatedly think about negative events/thoughts is termed rumination, and it is conceptualised as the tendency to attach negative interferences to stressful life events/stressors, hence rumination can be context-specific as opposed to trait rumination[18]. People with this brooding response style tend to exacerbate the negative affects while avoiding the stressors as they can cause heightened psychological and/or physiological stress reactivity[19 – 21]. Rumination has been consistently found to be associated with depression and anxiety[22,23], yet its applicability to PA behaviours has been largely overlooked[24]. Only few studies have examined the relationship between rumination and PA behaviours. For example, one study found that

high ruminating children were notably less physically active than low ruminators, and that their reactivity to the speculated stressor (PA measurement) seemed to have manifested in their PA behaviours, as shown in an initial inflation of PA level followed by a substantial drop by the end of the 3-week measurement period [25]. This change in PA behaviour could be explained by the depletion of cognitive resources that previously sustained the inflated PA level, which was prompted by the hyper-vigilant trait that ruminators exhibit when being confronted with stressors[25]. A more recent study suggested that impulsivity and amotivation mediated the relationship between rumination and exercise behaviours in adults[24]. From these studies, it appears that high ruminators are less likely to be physically active than low ruminators possibly due to their tendencies to dwell on PA-related negative thoughts and/or experiences. Evidence from child development literature also suggests that high ruminators tend to be more susceptible to cardiovascular disease risks and that they are more likely to ruminate about their body image[25,26]. Whether the former is due to psychophysiological or behavioural response to stress is unknown, but furthering our understanding into rumination as a potential self-regulatory mechanism that underpin PA behaviour is warranted.

A common limitation for the above-mentioned studies on rumination and PA behaviour is that the instruments used to measure rumination tendencies were for evaluating trait rumination, and not specific to PA behaviour. To date, there are no validated instruments to measure ruminative tendencies towards PA participation. Therefore, a second aim of this investigation (Study 2) is to develop and validate the PA-specific Rumination Scale for Children (PARSC), and the items for the new instrument will be generated from the themes on intrinsic barriers to PA participation in Study 1.

Method

The aim of Study 1 is to explore the intrinsic facilitators and barriers of PA through the lived experiences of school-aged children. The themes generated from the latter will inform the development and validation of the PA-specific Rumination Scale for Children (PARSC) in Study 2.

Study 1

Participants

Table 1 summarises the sample characteristics. One hundred and forty-three children aged 6 to 10 years (Year 2 to 5; M_{age} = 8.77yrs, SD = 1.05; 50% boys) assented to participation and parental consents were received. Participants were recruited from 4 government-aided primary schools in the southwest of UK between January and April 2017. Those with physical/intellectual disabilities or recent physical injuries that would hinder everyday PA were excluded from the study. All measures and procedure were approved by the Institutional Ethics Board.

Table 1

Descriptive statistics of the sample characteristics for Study 1 and Study 2.

		N (boys, girls)	Mean age ± sd	Mean steps ± sd
Study 1	Total sample (Sample 1)	143 (71, 72)	8.77 years ± 1.05	10,181.73 ± 2,741.10
Study 2	Total sample (Sample 2)	389 (177, 212)	8.63 years ± 1.32	—
	Sample included for internal validity, internal consistency, test-retest reliability analyses	382 (170, 212)	8.63 years ± 1.32	—
	Sample included for factors predictive of PA-specific rumination tendencies in regression analysis (a sub-sample from Study 1)	87 (45, 42)	8.94 years ± 1.02	10,106.64 ± 2,717.90

Procedure

To aid the random selection of participants for focus group discussions based on their habitual PA, all participants were given a peizo-electric pedometer (New Lifestyles 800) to wear over a nylon belt on their left hips every day during waking hours, except during water activities, for 3 consecutive weeks. The New Lifestyles 800 has presented good validity as a measurement tool for use with school-aged children[27]. Participants with at least 1 weekday and 1 weekend day of data, with daily steps between 2,000–30,000 inclusive, were included in the analysis[27,28]. To account for potential reactivity, all pedometers were sealed and only Week 3's data were used to categorize participants into low, moderate and high PA for each year group[27].

Focus groups were composed based on sex, year group and high or low activity level, hence each year group consisted of at least one group of high PA boys, one group of high PA girls, one group of low PA boys and one group of low PA girls[28]. Most focus group discussions lasted for 20–30 minutes and were led by the lead researcher who had extensive experience working with children and in qualitative work. Some year groups had more than 2 focus groups due to insufficient time to

complete the earlier sessions. Most focus groups consisted of 3 participants each, but due to absence on the date of discussions, some groups only had 2 participants. Altogether 53 participants were included in 19 focus group discussions across all year groups, and all focus group discussions were conducted within the respective school venues (see Table 2 for details).

Semi-structured interview questions were prepared to prompt the discussions and these questions primarily tapped into participants' daily routine and the reasons for (not) enjoying PA[29]. First and

foremost, the concept of PA was clarified at the beginning of each session to ensure that the participants understood that all sports, exercise, play or everyday activities (e.g. walking to school) would be considered as PA. To aid the discussions, participants were first asked to draw the activities they enjoyed, or did not enjoy, so as to allow time to reflect on their experiences and further engage in the subsequent discussions[30]. In particular, participants were asked to reflect on the thoughts that conjured up as they were drawing the activities that they disliked, or if they were to participate in them, as this information would serve the purpose of Study 2. All focus group discussions were audio-recorded and transcribed verbatim.

Table 2
Composition of focus group members in each year group.

	Year 2	Year 3	Year 4	Year 5
High active	1FG x 3 boys 1FG x 2 girls	1FG x 3 boys 1FG x 3 girls	1FG x 3 boys 1FG x 3 girls	2FGs x 3 boys 2FGs x 3 girls
Low active	1FG x 3 boys 1FG x 3 girls	1FG x 3 boys 2FGs x 3 girls	1FG x 3 boys 1FG x 3 girls	2FGs x 3 boys 2FGs x 3 girls

Note

FG = focus group. Physical activity level was objectively determined by mean daily steps in Week 3 of physical activity measurement.

Focus group analysis

Thematic analysis was adopted using QSR NVIVO 12 software. A deductive approach was initially employed, followed by an inductive approach, as recommended for analyses that are partially addressing existing theories[31]. Two researchers experienced in qualitative research conducted the analysis which involved comparisons of themes explored after each focus group transcript and collapsing related themes into higher order themes. Any disagreements were discussed and subsequently resolved, such as in the case of removing ‘positive moods’ as a higher order theme but including it as lower order theme under ‘sensations’. This process concluded when both researchers agreed that the analysis had reached saturation and that the final coding scheme could sufficiently addressed the study aim.

Results

Internal validity and internal consistency using Rasch analysis

Original scale

For the original PARSC analysis, six well-distributed class intervals were utilised (n = 50–77). Adequate overall fit of PARSC to the Rasch model is demonstrated from the non-significant Chi-square probability value ($\chi 2$ (50) = 58.41, p = .19). Fit residual values for all items were within ±2.5, suggesting good item fit. A single person was identified with fit residual > 2.5 (indicting an unexpected response pattern), and 24 people were identified with fit residual < -2.5 (indicating a predictable response pattern). These people were retained within the analysis, as they were not considered to be overly corrupting the analysis.

One pair of items, items 2 (How often do you think you might get hurt?) and 8 (How often do you think serious accidents may happen?), demonstrated local dependency with a residual correlation of 0.12, > 0.2 compared to the mean of all residual correlations. As the item set has no pre-existing clustering, the comparative groups for the unidimensionality series of t-tests was determined through the positively loading and negatively loading items from a principal componentsanalysis of the residuals. The series of t-tests reported that 3.93% of cases demonstrated significant differences between the two comparative person estimates that were generated.. This suggests unidimensionality of the scale. Furthermore, DIF analyses suggest that four items display DIF-by-sex, and three items display DIF-by-age group (Bonferroni adjusted p-value > 0.05).

The person-item threshold distribution suggests that distribution of the person estimates and item threshold was reasonably matched (or targeted) (mean ± sd person logit = − .59 ± .89, with average scale item mean = 0.00 logit), i.e., item difficulty could adequately address the range of rumination tendencies (Fig. 1a). Regarding the response categories, disordered thresholds were evident for all items except item 4 (How often are you think you might feel ‘funny’ in your body, like in the tummy, in the arms and legs, or feel ‘tired’?), indicating that the response scale is not working in the expected manner for most items. Figure 2a illustrates the category probability curve for item 6 as an example. This suggests that 4-response options appears too many to be operational within this sample., Inspection of the person-item map indicates that categories 2 and 3 (‘sometimes’ and ‘often’) appeared to be the most difficult to endorse.Based on this information, a generic recode was applied across all items, where categories 2 and 3 (‘sometimes’ and ‘often’) were treated as an equivalent response, to deliver an implied 3-response category format.

Revised scale after rescoring

After rescoring, the class interval distribution was reviewed. Due to the uneven distribution from 42–126 across the 6 intervals, we chose a 5-class interval structure in order to reduce the variability between each class (57–94) before proceeding with model fit analyses. The revised scale demonstrated good overall fit to the Rasch model ($\chi 2$ (40) = 52.36, p = .09). All individual items satisfied the model fit criteria. One participant displayed a fit residual > 2.5 (2.61), and 30 participants displayed fit residuals < -2.5. No local dependency was evident from the residual correlation matrix, and the scale displayed (series of t-tests = 4.71%).

Rescoring of the response scale also saw more evenly distributed thresholds (Fig. 2b) and the person-item threshold map depicts adequate targeting between item difficulty and person attributes (Fig. 1b). DIF was still present for sex (items 1, 6 and 7– Uniform DIF) and age group (items 1 and 5 – Uniform DIF). A subtest was conducted for each person factor including the identified items, and analyses of variance indicated that the DIF items cancelled each other out at test level (p = .07 and p = .11 respectively), hence no further actions were taken to address the DIF issue. Lastly, internal consistency of PARSC was deemed satisfactory with PSI = .73

Test re-test reliability and factors predictive of PA-specific rumination tendencies

Utilising the logit (interval) scores of the revised PARSC, ICC coefficient suggested that the revised PARSC possessed sound test-retest reliability (ICC = .77; 95% CI, .72 – .81). To assess factors predictive of PA-specific rumination tendencies, 87 cases were retained for regression analysis, with avoidant coping, objective and self-report PA level as the predictors. Results suggest that PA rumination tendencies are predicted by self-perceived PA level (β = .15, p = .006; 95% CI, .04 − .25) and avoidant behaviour (β = .10, p = .02; 95% CI, .02 − .19), but not objective PA (β = -8.31E, p = .36), and 15% of the variance can be explained by the model.

Discussion

In recent years, there is growing emphasis on the automatic (implicit) processes that drive health behaviour (e.g. impulsivity, attention bias) over and above the reflective (explicit) processes that assume individuals' awareness (e.g. intention, self-efficacy)[51]. Focus on the latter might be another key reason for the moderate effectiveness of behaviour change interventions as the health decisions that people make are often less conscious than the explicit processes suggest[52]. Essentially, rumination, an emotion coping mechanism that is closely linked to implicit cognition such as attention bias and affective processes, could play a vital role in hindering our decisions to engage in positive health behaviour. While rumination has shown to be a potential self-regulatory mechanism that drives PA behaviour, our understanding of this coping style in its application to health behaviours is still in its infancy. This is partly attributable to a lack of a psychometric instrument to measure PA-specific rumination. Our study is the first to develop and validate a rumination scale specific to PA behaviour for school-aged UK children. The PARSC with a 3-point response scale has demonstrated sound internal validity, internal consistency and test-retest reliability. PA-specific rumination tendencies were also found to be predicted by self-perceived PA and avoidant coping. A main strength of this validation study is the use of Rasch modelling to generate meaningful interval scores for analysis[55]. The association between avoidant coping and rumination is as expected, as confronting stressors are undesirable for ruminators due to their heightened reactivity to stress, resulting in their urge to avoid the source of stress[56,57]. However, it is surprising that self-perceived PA, and not objectively measured PA, is linked to rumination tendencies. It is possible that the shrunken sample size in the analysis, due largely to attrition from PA measurement (40%), failed to capture the extreme ends of the PA spectrum while the possible underestimation of light-moderate PA and

overestimation of moderate-vigorous PA from the self-report might have artificially inflated the variability[58]. Future studies should consider measuring objective PA in a larger sample to ascertain the predictive validity of PARSC.

As the PARSC was developed through accounts of the lived experience of children from the UK, it can be considered as a culture-specific instrument. Nonetheless, it can potentially be used for other child populations. Findings from previous qualitative studies on barriers of PA with Hispanic and Australian children are largely similar to the themes identified in the current study, however, additional prominent themes from the former include concerns about getting 'sweaty', and parent-driven rules such as expectations of behaviour indoor, and neither studies identified uncleanliness, sex stereotype and lack of a sense of purpose from their participants[15,16]. These discrepancies could potentially stem from cultural differences in parenting practice, and from the fact that focus of these studies is less on the intrinsic barriers but more on environmental barriers as well. Therefore, if PARSC is used in children from different cultural backgrounds, it is recommended that further validation process is in place to ascertain its suitability.

For some of the intrinsic barriers that are relatively uncontrollable by individuals, such as sex stereotype, uncleanliness, unfair play, previous negative experiences and to some extent, injuries and accidents, it is important for researchers and education professionals to help children overcome them by building resilience in order to minimize their influence on children's PA. PA interventions can also consider implementing strategies that address the other barriers through effective coaching. For example, understanding that some children find the 'out of breath' experiences disconcerting, PE sessions can focus on pacing strategies for a more even distribution of effort intensity so that prolonged PA can be enjoyable, and at the same time, awareness about this sensation can be raised as part of normal physiological functioning so that children would not consider this to be negative[59]. Intriguingly, when children expressed that a lack of purpose being a barrier, they did not consider staying healthy as a purpose, yet, all agreed that PA is a means to lead a healthy lifestyle. This certainly has implications on the content of health messaging in PA interventions and public health campaigns, as focus on health promotion is perhaps less likely to motivate children than the intrinsic facilitators that attract them to engage in PA due to its lack of relevance to children's value[60].

Lastly, regarding the intrinsic facilitators, they generally agree with previous research in the area and these factors, such as sense of competence and social facilitation, can certainly be incorporated in children's PA experiences by PE teachers and parents[14]. For example, children's sense of accomplishments can be enhanced through effective goal-setting or errorless learning in the skill learning process as well as raising self-reflective ability[61]; their enjoyment gained from self-expression can be satisfied by allowing autonomy to create their own games or dance moves[14], and the effect of social facilitation can be optimized through role modelling or amicable competitions[62]. Crucially, our data suggest that children are naturally drawn to movements and play, so any attempts to provide such opportunities are likely to reduce time spent sedentary and potentially reduce cardiovascular disease

risks[63]. All of these strategies can be implemented within PE classes or integrated into PA interventions. In fact, the mentioned factors have provided support to existing theories of behaviour change, such as Self-Determination Theory and Social Learning Theory, but our findings have presented further insights into how these theories, and the associated PA determinants, may operationalise in a context specific to PA behaviour in UK children through which future PA interventions can model on.

Additionally, some intrinsic facilitators are unrelated to existing theories and less explored in PA behaviour literature. Specifically, children seemed to derive PA enjoyment from their sensory experiences and energy boost. The latter is particularly interesting as this factor seems to be novel within existing literature. As discussed previously, even though the concept of health might not be meaningful to children, having the energy to function in everyday life and to participate in enjoyable pursuits seem to be a crucial motivator for some children to engage in PA. This finding also suggests that children's sensory experiences should not be undermined, hence strategies to promote an active lifestyle can include an emphasis of positive sensory experiences during and after PA, a concept similar to mindfulness training in encouraging attention to the present-moment feelings and sensations[64].

A few limitations of the current study are worth noting. First, due to the limited linguistic repertoire and self-reflexive ability, drawing in-depth information from the youngest age group in focus group discussions was challenging. Focus group discussions might not be the best way to understand the lived experience of children under 7 years of age, instead, we might have to rely on reports from parents and teachers who can explore children's in-the-moment PA experiences. Moreover, despite possessing sound psychometric properties, further confirmation of construct validity of PARSC is called for, due to a lack of validated rumination scales for children. The psychometric assessment led to a post-hoc rescaling of PARSC, and some DIF was indicated for both sex and age groups. Although the post-hoc scoring appeared to work favourably, and the impact of the DIF appeared to be small at the test level, this should be further tested by a different sample in order to confirm the psychometric properties of the PARSC, and to determine whether a 3-response category format is appropriate when tested prospectively. Nonetheless, we consider the themes identified from the focus group discussions and the phrasing of the items indicative of the construct, and potentially, future studies can lend support through neuroimaging or psychophysiological response to PA-related stimuli with children of extreme ends of the PA spectrum.

Conclusions

To conclude, the current study has provided an in-depth understanding of the culture-specific intrinsic facilitators and barriers of PA in UK children, and through the themes from the latter, PARSC was developed and its psychometric properties were confirmed. We encourage researchers and policy makers to consider our qualitative findings in the design of future PA interventions for this population, and for education professionals to effectively promote PA to young children, especially those with relatively high PA rumination tendencies as identified through PARSC. While it is crucial to focus on the intrinsic facilitators to enrich children's PA experience, strategies to address the intrinsic barriers that may become sources of rumination against PA, such as resilience development, should also be considered. Through

PARSC, we hope to advance our understanding of rumination as a self-regulatory coping mechanism that underpins PA behaviour and metabolic health in young children and the potential strategies to encourage adoption of adaptive coping style in the promotion of positive behaviour change.

Declarations

Ethics approval and consent to participate Ethical approval was obtained from the Northumbria University Research Ethics Board. All participants assented to participation and their guardians also provided written informed consent. Consent for publication No details of individuals have been included in the manuscript. Availability of data and materials The dataset used and/or analysed for the current study is available from the corresponding author on reasonable request. Competing interests The authors declare no conflicts of interest. Funding Not applicable. Authors' contributions The study was conceived by FL who also collected and analysed data for both studies. JS co-analysed the qualitative data and MH co-analysed the quantitative data. All authors contributed to manuscript preparation. Acknowledgements The first author would also like to thank her former undergraduate students, Danielle Sweeting and Danielle Sefu, for conducting the focus group discussions and preparing the transcripts.

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Figures

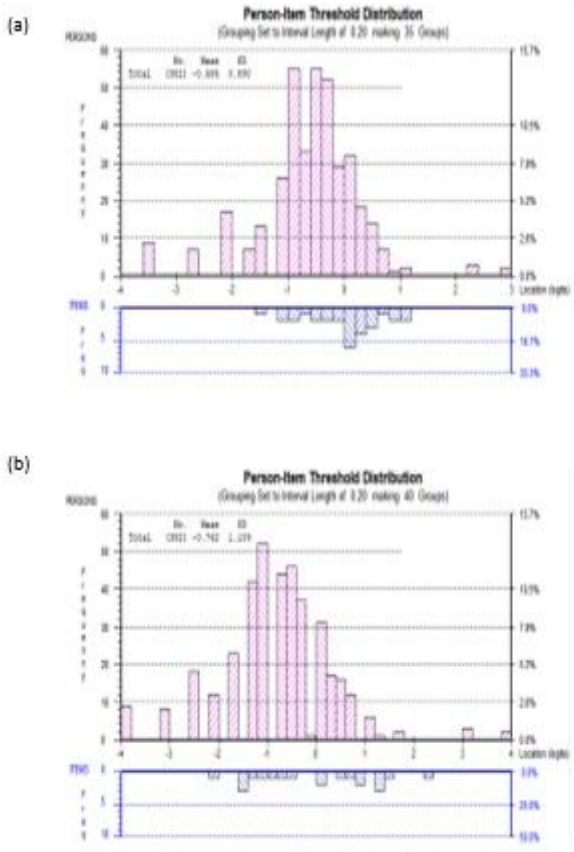

Figure 1

Person-item threshold distribution maps. Each map illustrates the extent to which participants' PA-specific ruminative tendencies (top) matches item contribution to the construct (bottom). The logits

(location) scale on the x-axes represent a standardized score where the mean rumination score and mean item contribution is set to 0, and one logit = one SD. The y-axis of the top histogram shows the distribution of standardized scores while the y-axis of the lower histogram shows the probability of endorsing a given score for a particular item. Map (a) displays targeting between item difficulty and person attributes of the original scale and map (b) depicts that of revised scale after rescoring.

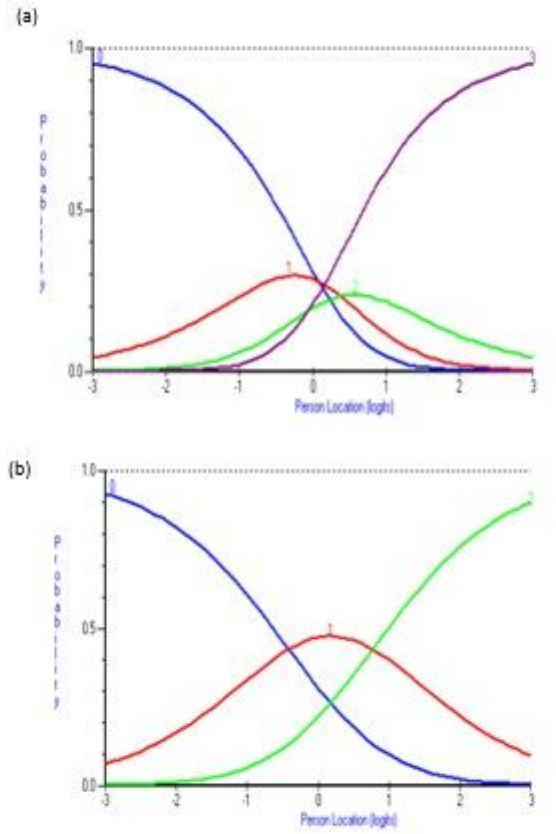

Figure 2

Category probability curve of item 6 (a) from the original scale and (b) after rescoring.

Supplementary Files

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- STROBEchecklistv4crosssectional.pdf