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Development and validation of the Movement Imagery Questionnaire for Children (MIQ-C)

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ABSTRACT

The ability to perform movement imagery has been shown to influence motor performance and learning in sports and rehabilitation. Self-report questionnaires have been developed to assess movement imagery ability in adults, such as the Movement Imagery Questionnaire 3 (MIQ-3); however, there is a dearth of developmentally appropriate measures for use with children. To address this gap, the focus of this research was to develop an imagery ability questionnaire for children. This process involved adaptation of the MIQ-3 via: i) cognitive interviewing with twenty children, ii) validation with 206 children by examining its factor structure via multitrait-multi method confirmatory factor analysis, and iii) examination of test-retest reliability with 23 children. The findings of Study 1 led to changes to the wording of the questionnaire and modifications of the instructions to successfully adapt the MIQ-3 for children aged 7–12 years. The validation undertaken in Study 2 found that a correlated-traits correlated-uniqueness model provided the best fit to the data. Finally, test-retest reliabilities varied from fair (for external visual imagery) to substantial (for kinesthetic imagery). With respect to ease of imaging, no significant gender or age-group differences were noted. However, significant difference were found among the three imagery modalities ($p < .001$), with external visual imagery rated as easiest to image and kinesthetic imagery rated as the most difficult. Taken together, findings support the use of the MIQ-C for examining movement imagery ability with children.

1. Introduction

The ability to represent action in the mind, i.e., create a mental image, has been found to be important for the development, performance, and learning of motor tasks (Guillot & Collet, 2008). Mental imagery is increasingly used as an intervention strategy to enhance performance in sports as well as recovery in motor task performance in rehabilitation (Cumming & Williams, 2012). It is hypothesized that the mental imagery of action provides a window into how a person represents action in the brain for effective action planning (Gabbard, Caçola, & Bobbio, 2011; Skoura, Vinter, & Papaxanthis, 2005).

The mental performance of an action, without physical execution of the movement (Jeannerod & Decety, 1995), is a complex and multi-faceted construct (Hall & Martin, 1997; White & Hardy, 1995). Vealey and Greenleaf (2001) describe imagery as using all senses to create or re-create an experience in the absence of external stimuli. While imagery is recognized as being a poly-sensory experience, the most common modalities considered in sports and rehabilitation research are visual and kinesthetic. The kinesthetic component refers to how the person "feels" the movement and involves the internal awareness of the position and movements of the parts of the body, as well as the force and effort perceived during movement. The visual component, on the other hand, refers to the representation of what the individual 'sees' (such as space, size, and amplitude) (Callow & Waters, 2005). Mental imaging of action can also involve different perspectives: internal (or first person) perspective or external (or third person)

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perspective (White & Hardy, 1995). When one images a movement as if one is actually doing the movement, this is referred to as using an internal perspective (Jeannerod, 1995; McAvinue & Robertson, 2008). One can use an internal perspective within the kinesthetic and/or within the visual modality. The external perspective, however, refers to seeing oneself doing the movement as if watching oneself on television or a video (Jeannerod, 1995; McAvinue & Robertson, 2008) and so usually involves the visual modality rather than the kinesthetic modality. Jeannerod (1995) uses the term motor imagery when referring to images "experienced from within" (p. 1419), i.e., of the first person and involving mostly kinesthetic representation. As such, while a motor representation is described as containing both kinesthetic and visual aspects of an action, it is generally understood that these are from an internal perspective (Jeannerod, 1995; McAvinue & Robertson, 2008; Roberts, Callow, Hardy, Markland, & Bringer, 2008). Movement imagery, on the other hand, seems to include both external and internal perspectives (McAvinue & Robertson, 2008). Although, recent research points out that imagined movement from both first and third person perspective may involve the same representations (Anquetil & Jeannerod, 2007), thus indicating that the distinction between first and third person perspectives needs for further investigation. For this paper, the term movement imagery will be used to encompass all perspectives and modalities of imagery.

All individuals are able to create and use images; however, some are better at this than others. This ability to form the image and the quality of the image constructed is known as imagery ability. It determines the extent to which imagery is used by an individual and so influences the degree of success obtained through these interventions (Cumming & Williams, 2012). In their review of the literature, Guillot and Collet (2008) stated that there is a strong association between movement imagery ability and motor performance and learning. Research suggests that imagery ability can be improved with training so as to benefit motor performance and learning (Cumming & Williams, 2013; McAvinue & Robertson, 2009). As such, improving movement imagery ability may be beneficial for individuals who demonstrate a weakness in this area, such as children with coordination difficulties (Gabbard & Bobbio, 2011). To be able to assess whether improving movement imagery ability could have such benefits, however, one needs to have a measurement tool that assesses this ability. Although, several measures exist for adults, few have been devised for use with children.

1.2. Measuring movement imagery ability in children

Movement imagery has not been so widely studied with children as it has been with adults. While we know that children have the ability to create and use movement imagery (Gabbard, 2009), to date, we really know very little about the imagery capabilities of children. What we do know of imagery ability in children has been investigated using three main paradigms: mental rotation, mental chronometry, and self-report questionnaires (Heremans, Helsen, & Feys, 2008; McAvinue & Robertson, 2008).

Mental rotation is an implicit measure of imagery ability whereby subjects unconsciously make a decision regarding a visually presented stimulus as accurately and quickly as possible (McAvinue & Robertson, 2008). For example, if shown a hand oriented at different angles on a computer screen the subject must indicate if it is a right or a left hand. With adult subjects, it was found that there is a linear relationship between amount of rotation and reaction times (Estes, 1998). Using the mental rotation paradigm, Estes (1998), and Funk, Brugger, and Wilkening (2005) found that children as young as 6 years can mentally rotate visually presented objects, and that subjects aged 14 had results comparable to adults indicating that this ability improves with age.

With mental chronometry and self-report questionnaires, the subjects are asked to consciously image performing a movement, and are therefore known as explicit measures of imagery ability (Jeannerod, 1995). Mental chronometry is a strategy used to compare real and imagined movement times (e.g., imagining reaching for an object vs actually reaching for it). Better movement imagery ability is inferred by the similarity in movement times (McAvinue & Robertson, 2008). A study that used mental chronometry with children and adults found that, when compared to adults, all children imaged their movements with shorter durations than they executed them. This suggests that although children can perform movement imagery, imagery ability is not completely developed in children aged 6–10 years (Skoura, Vinter, & Papaxanthis, 2009). This finding is further supported by results from Molina, Tijus, and Jouen (2008), where no correlation was found between real and imagined movement durations in children aged 5 years, thus indicative of a lack of imagery ability. Similar results using mental chronometry were found by Deconinck, Spitaels, Fias, and Lenoir (2009), and Caeyenberghs, Wilson, van Roon, Swinnen, and Smits-Engelsman (2009).

The results of these studies indicate that movement imagery ability appears to develop between the ages of 7–12 years (Caeyenberghs, Tsoupas, Wilson, & Smits-Engelsman, 2009) and that these changes look like they coincide with the development of cognitive processes implicated in motor representation and necessary for the programming and execution of action (Molina et al., 2008). There seems to be consensus among researchers that motor imagery ability improves with age and experience due to the refinement of internal models (Caeyenberghs et al., 2009; Skoura et al., 2009).

Evidently, methods measuring temporal congruence between imaged and actual times, such as mental rotation and mental chronometry, provide important information on the characteristics of imagery ability related to timing, such as duration and speed. These measures focus primarily on a global movement rather than providing details of ongoing mental process and so do not capture the richness of the imagery experience, nor do they specify imagery perspectives being used, thereby failing to provide information on the vividness, or perspective used (Collet, Guillot, Lebon, MacIntyre, & Moran, 2011; Heremans et al., 2008). While other methods, such as mental chronometry or mental rotation, are fairly objective ways to test imagery ability, the use of a questionnaire is a task-independent method for measuring movement imagery ability. Unlike these other methods, self-report movement imagery questionnaires provide information on ease of generation of imagery and its vividness with respect to the imagery perspective being used, thus addressing some of the weaknesses identified with mental chronometry and mental rotation (Williams et al., 2012).

Though several movement imagery ability questionnaires measures exist, these have been validated only with adults. To date, no movement imagery ability questionnaire exists that has been developed for use with children. Considering the likely developmental changes that occur with imagery ability in children, an important first step in understanding its influence in children's motor performance and learning would be to develop a movement imagery ability measure for children.

Both Isaac and Marks (1994) and Taktek, Zinsser, and St. John (2008) used the Vividness of Movement Imagery Questionnaire (VMIQ), developed for adults, with children. Using this questionnaire with participants from 7 to 50 + years of age, Isaac and Marks found significant developmental changes in imagery ability in both children and adults. Furthermore, children with poor movement control were also noted to be poor imagers, with 42 percent