Associations between socio-ecological factors and motor competence amongst 5–6-year-old children from deprived areas of Northwest England

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Abbreviations

DMA	divergent movement ability
FMS	fundamental movement or motor skills
MC	motor competence
MCr	motor creativity
MP	motor proficiency
MPA	moderate physical activity
MVPA	moderate to vigorous physical activity
PA	physical activity
SAMPLE-PE	Skill Acquisition Methods Fostering Physical Literacy in Early-Physical Education
TGMD-3	Test of Gross Motor Development – version 3

Abstract

Background: Learning to move competently is an essential foundation for participation in physical activity (PA). Previous literature has reported that young children with high levels of motor competence (MC) can be predicted to have higher levels of PA participation during primary and secondary school years, and that high MC is protective against excess weight gain. Yet, little is known about the factors that influence the development of MC at a young age, particularly amongst children living in highly deprived areas. The aim of this study was, therefore, to examine the association between socio-ecological factors and MC development in children aged 5-6-years-old living in an area of high deprivation.

Methods: This cross-sectional study used baseline data from the SAMPLE-PE cluster randomised controlled trial. Twelve primary schools and 360 pupils were recruited to the project from areas of high deprivation within a city in Northwest England. Parents/carers were invited to complete a questionnaire about their child's individual (e.g. PA behaviours and preferences, child's personality), social (e.g. family demographics, social support, PA rules and barriers) and environmental (e.g. time spent outside and home environment) factors. MC was assessed via *motor proficiency,* using the Test of Gross Motor Development (TGMD-3), and *motor creativity,* using the Divergent Movement Ability Test (DMA). Linear regression models examined the association between individual, social and environmental factors and their contribution to motor proficiency and creativity.

Results: The final sample included 100 children with complete questionnaire and MC data (50% boys/girls, age mean 6.0 years, 0.4 SD). No socio-ecological influences were associated with motor proficiency. For motor creativity, significant associations were only found among individual level factors, with positive associations observed with deprivation decile (B=2.872; 95% CI= 0.22 to 5.53; p=.034) and minutes spent in Total PA between 3-5 years-old (B=0.001; 95% CI= 0 to 0; p=.032), though a negative association was found for Total PA activity minutes between the ages 1-2.9 years (B=-0.002; 95% CI= 0 to 0; p= .022).

Conclusion: This was the first study to explore associations between socio-ecological factors and both motor creativity and proficiency in young children. Individual level factors of multiple deprivation and total PA predicted motor creativity; however, no significant associations were found for motor proficiency. Further research is required to understand the direction of the relationships between PA and motor creativity in young children, and to explore factors affecting the development of motor proficiency. Research could inform planning and practice in PE to include opportunities to develop motor creativity and therefore motor competency.

Declaration

I declare that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Collaborative group project

This thesis is part of a wider programme of research: SAMPLE-PE.

I wrote the introduction, methods, completed the statistical data analysis, and wrote the corresponding results and discussion.

I conducted data collection for Test of Gross Motor Development-3, Test of Stability Skills and Divergent Movement Assessment at baseline assessments, together with Matteo Crotti, Sebastian Schwarz, Katie Fitton Davies, Laura O'Callaghan and Aina Cid I Centelles.

I completed video data coding for movement competence for 87 children (~30% of sample) at baseline. The remaining videos were analysed by Katie Fitton Davies, Matteo Crotti, Laura O'Callaghan and Aina Cid I Centelles.

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Introduction

After many years of concerns over declines in children's health and levels of physical activity (PA) (Cheung et al., 2021; Sport England, 2021), the focus of much research has now turned to understand the reasons *why* many children are not sufficiently active. It is suggested that there is an interconnection between PA, and motor competence (MC) (Stodden et al., 2008), with research supporting the theory that children with higher MC are more likely to remain physically active throughout their life (Cohen et al., 2015; Foweather et al., 2015; Barnett et al., 2021). Participation in PA influences children's development of MC, and in turn, their MC influences their motivation and engagement in PA (Stodden et al., 2008; Robinson et al., 2015; Utesch et al., 2019). For several years now it has been found that PA and MC levels are low in children in the UK and that children from more deprived areas are more likely to be less active and competent (Sport England, 2021). Understanding the correlates of MC is, therefore, important to help parents/carers and practitioners in this field develop effective means to encourage engagement and motivation in PA and to prevent future inactivity and associated negative health consequences (Pill and Harvey, 2019; Valentini et al., 2020).

MC research is evolving with a clear focus on understanding affordances for movement so that children can be supported to develop better competence. While the importance of MC for children's health and development is well established (e.g., Cohen et al., 2015; Foweather et al., 2015; Holfelder & Schott, 2014; Lai et al., 2014, Barnett et al., 2021), there is not a clear understanding of how to best promote MC development in young children. The socio-ecological model provides a framework for understanding individual (e.g., demographics and PA experiences), social (e.g., family and home demographics) and environmental (e.g., space and equipment to be active) influences that may contribute to MC development (Rhodes, McEwan & Rebar 2019). This thesis aims to explore associations between socio-ecological factors and MC amongst 5–6-year-old children from deprived areas of North-West England.

The thesis is structured into sections, beginning with a critical review of the literature relating to the importance of PA, before discussing MC as a foundation for PA, health and development; the prevalence of MC and what is known about movement proficiency (MP) and movement creativity (MCr), and an overview of existing research in these areas. The thesis will then outline the methodological approaches that have been employed in this study, and report the findings of the study, including the implications in relation to the major themes, as well as providing recommendations for future research and practice.

Literature Review

Physical Activity

PA refers to any movement of the body that uses energy including leisure time and transport to and from places. PA for young children may include walking, crawling, running, jumping, balancing, climbing in, through and over objects, dancing, riding wheeled toys, cycling, jumping rope etc. (World Health Organisation 2019). The United Kingdom (UK) Chief Medical Officer's (CMO) recommendations and wider international guidelines broadly state that the minimum daily amount of moderate to vigorous PA (MVPA) recommended for children aged between 5-18 years old is at least 60 minutes a day (UK Department of Health, 2020; Australian Government Dept of Health, 2021; US Department of Health and Human Services 2018; WHO 2019). PA is vital to the physical, psychological/social, and cognitive health of school-aged children. Indeed, a systematic review of the benefits of PA in childhood and adolescence indicates favourable associations between PA and a plethora of health indicators (Poitras et al., 2016), finding strong, consistent relationships between total PA and adiposity, several cardiometabolic biomarkers, aspects of physical fitness (aerobic fitness, muscular strength, and endurance), and bone health. Given that learning and development opportunities and PA experiences in the early years' influences participation in later life (Stodden et al., 2008), it is important that positive PA relationships are forged in early childhood. Poitras et al. (2016) review also found support for favourable relationships between total PA and quality of life/well-being, and motor skill development.

Despite the well-established benefits of PA, figures from the latest Active Lives Children and Young People Survey, covering the 2020/21 academic year shows only 44.6% (3.2 million) of children and young people aged 5-18-years-old in England met the CMO guidelines, this was equal between boys and girls, ages 5-16 years (Sport England, 2021). These figures differ to the 2019/20 report that showed 47% of Boys (1.7m) are more likely to be active than 43% of girls (1.5m), with a gap of 213,000 between them. This didn't show a statistically significant decrease in PA compared with the previous year 2018 to 2019. Furthermore, if children live in an area of higher deprivation evidence suggests that the risk of being inactive increases and activity levels decrease (Sport England, 2021). Thus, it is important that researchers, parents/carers and practitioners understand what factors are influencing PA behaviours among children living in areas of high deprivation, and how their development can be supported.

Motor Competence

Motor competence (MC) is often referred to in research as many different terms, e.g., motor performance, ability, or proficiency, foundational movement skill competency or fundamental motor skills (FMS), and motor coordination. This thesis will define the term MC as the ability of an individual to perform a goal related movement with coordination,

accuracy and relatively error free (Arnon & Elliot, 2005: Robinson et al., Rudd et al., 2016). Children who can perform basic FMS such as running, throwing, kicking, and catching in a consistent and efficient manner are often referred to as displaying motor competence (Gabbard, 2011).

Children with a good level of MC have been found to have higher levels of PA (Williams et al., 2008; Duncan et al., 2022); therefore, learning to move competently appears to be essential in the foundation of participation in PA (Logan, Robinson, Wilson & Lucas, 2012; Robinson, Stodden, Barnett, Lopes, Logan, Rodrigues & D'Hondt, 2015; Stodden, Goodway, Langendorfer, Roberton, Rudisill, Garcia & Garcia, 2008). As Hulteen et al. (2018) suggested, the development of foundational movement skill competency will, just as motor development models show, support and maximise opportunities for participation in PA. High levels of MC have also been associated with healthy weight status (Lubans et al., 2010), and higher cardiorespiratory fitness and musculoskeletal fitness across childhood and adolescence (Cattuzzo et al. 2016). The development of MC is also associated with positive trajectories of academic achievement (Harrowell et al., 2018), mental health (Lingam et al., 2012), and quality of life (Zwicker et al., 2013). Competency in multiple movement skills is also linked to a range of positive health outcomes including children's PA participation (Jones et al., 2020; Logan et al., 2015), physical fitness (Utesch et al., 2019), and physical self-perception (De Meester, Barnett, et al., 2020, Fitton-Davies et al., 2021). Moreover, Poitas et al. (2016) review reported an association between total PA and motor skill development in three out of five cross-sectional studies (Martinez-Gomez et al., 2012; Morrison et al., 2012; Larouche et al., 2014). Whilst MVPA and vigorous PA (VPA) were favourably associated with motor skill development, moderate PA (MPA) was not (Martinez-Gomez et al., 2012).

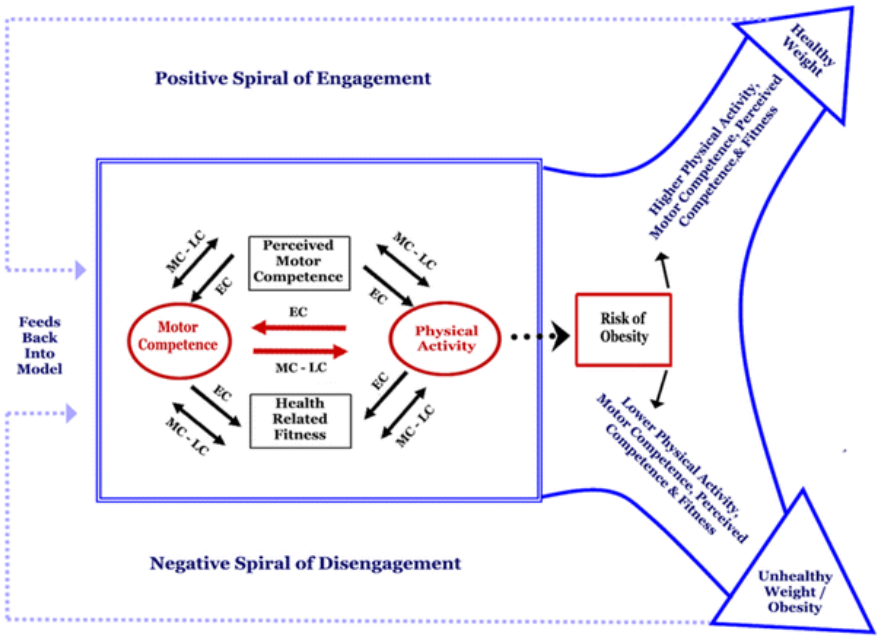

Figure 1. Developmental mechanisms influencing physical activity trajectories of children. (Stodden et al. 2008)

As possessing high MC increases the likelihood of children and adolescents participating in different forms of PA throughout life (Lloyd et al., 2014; Utesch et al., 2018), identifying correlates of high MC to target in interventions conducted in early childhood is warranted. High MC is not naturally acquired (Hardy et al., 2010), but develops through instruction and practice (Holfelder & Schott, 2014; Logan et al., 2015; Xin et al., 2020). Stodden et al. (2008) dynamic model illustrates how the relationship between MC and PA changes from early childhood to adolescence. It suggests that in early childhood MC will be developed and driven through the amount of PA opportunities a child is exposed to. However, a systematic review by Barnett et al. (2021) to compile evidence in support of Stodden et al.'s (2008) conceptual model, found insufficient evidence across 11 studies to support this hypothesis that PA has a pathway to MC. Indeed, previous research does not fully support the idea that high levels of PA and active play are enough to improve MC. Indeed, a number of early childhood intervention programmes have shown that when young children are provided with well-equipped free play time, they do not necessarily develop a high level of MC (Goodway & Branta, 2003; Robinson & Goodway, 2009a; Robinson, Rudisill, & Goodway, 2009b). Nevertheless, previous research has shown that there is a clear link between less PA and lower movement competency levels, and these are more likely among children from more deprived areas (Morley et al. 2015). This is a concern and increases the risks to cardiorespiratory fitness, likelihood to be overweight or obese, compared to children from lower areas of deprivation or that have higher MC (Lubans et al., 2010; D' Hondt et al., 2014; McWhannell et al., 2018).

Low levels of MC are a common finding reported in studies conducted among children in the UK. Duncan et al. (2022) produced an expert statement on MC of children in the UK and Ireland that summarises the findings of several studies that identify the issue. Roscoe et al. (2019), Foulkes et al. (2015), Morley et al. (2015), Duncan et al. (2019), Lawson et al. (2021), Eyre et al. (2018). Stratton et al. (2017), Johnstone et al. (2017) and Johnstone et al. (2019) have all highlighted concerns with the motor performance of primary aged children in the UK such as poor levels of development (Roscoe et al., 2019); a lack of mastery (Duncan et al., 2019, Lawson et al., 2021); delays appropriate to their age (Foulkes et al., 2015; Morley et al., 2015) and concerns in the inequalities observed by gender, ethnicity (Eyre et al., 2018) and deprivation (Stratton et al., 2017).

Motor Proficiency

Motor proficiency (MP) is defined as the child's technical ability to move proficiently by mastering FMS technical components and the specific abilities upon which performance is built, e.g. agility, balance, co-ordination, running speed (Morley et al. 2015). MP is an important aspect of motor skill development (Seefeldt, 1980) and in the acquisition of MC (Logan, Scrabis-Fletcher, Modlesky & Getchell 2011). Indeed, several studies have shown that children living in deprived areas are prone to lower levels of MP than children that live

in areas of higher socioeconomic status (SES) (Bellows et al., 2017; Ferreira, Godinez, Gabbard, Vieira, & Caçola, 2018; Liu, Hoffmann, & Hamilton, 2017; Morley, Till, Ogilvie, & Turner, 2015). Lower levels of MP in low SES areas could be explained by limitations such as less accessibility for sport equipment at home and reduced parental and financial support in the participation of organised sports (Yao and Rhodes 2015). Safety concerns could also influence children's MP levels as some children, in deprived areas, may be restricted from playing outdoors (Noonan, Boddy, Knowles, & Fairclough, 2016).

Collectively researchers, have raised concerns that the low levels of competence among UK primary school aged children do not catch up as they grow (Bryant, Duncan, & Birch, 2013) and it is believed that a child who does not develop MP is said to face a glass ceiling of motor proficiency development (Barela, 2013). This concern of low motor competence of UK children highlights the importance of investigating the influences on early MP development since a failure to make advancements during this stage may result in children attaining lower competence levels later in their development (Gallahue & Donnelly, 2003), risking health and developmental concerns in other areas associated with good MP development.

Motor Creativity

Another important facet of MC is motor creativity (MCr), which has been defined as the ability to produce numerous, original and functional motor responses to a stimulus (Wyrick, 1968, as cited in Torrents et al., 2021). Alternatively, Guilford (1967) states that MCr is a combination of perceptions into new and fresh motor patterns which can be either a solution to a pre-established problem or the expression of an idea or emotion by means of the human body. MCr research tends to focus on understanding cognitive or psychological issues rather than studying motor creativity itself (Moraru, Memmert, & Van der Kamp, 2016). Limited research has shown positive links between MCr and PA (Chow & Atencio, 2014), as children who are able to create and modify physical movement actions within different environments are also able to identify opportunities to engage in PA. At present there are limited methods of measuring motor creativity. Cleland & Gallahue (1993) look at motor creativity as the combination of motor fluency and motor flexibility. Motor fluency being the number of different movements, whilst motor flexibility is the variation in the different movements (Domínguez, Díaz-Pereira, & Martínez-Vidal, 2015). Cleland & Gallahue's (1993) Divergent Movement Ability (DMA) test is one of few, but similar tests that provide equipment/obstacles/settings for the child to interact with, allowing the observer to take note of each movement and its variations.

Developing Motor Competence

Young children are influenced and moulded by many factors that are individual to them and also around in the environment, affecting and shaping how they learn and grow.

The early years period sees the rapid growth of the brain and neuromuscular maturation (Malina, Bouchard, & Bar-Or, 2004), making early childhood a key "window of opportunity" for MC development. The developmental change in a child's motor skills is influenced by many critical determinants, which may be classified into the subsystems of requirements of the movement task (e.g., an obstacle's height or the size of a goal), the biology of the child (e.g., sex and heredity), and the environment (e.g., outdoor geography, educators' prompts to skill practicing). These subsystems individually and mutually either encourage or discourage skill acquisition (Gallahue et al., 2011; Newell, 1986). With the appropriate encouragement and opportunities for learning and practice, children have the developmental potential to achieve MC by age six years (Gallahue & Donnelly, 2003). Young children with confidence and fearlessness may encourage engagement and persistence in activities that foster MC (Stodden et al., 2008), and may also have higher levels of perceived competence (LeGear et al., 2012), which in turn has links to improved competence. Research does suggest that a stimulating environment and strong contextual support during the first years of life have a positive impact on child and motor development (Barnett et al., 2013; Gabbard et al., 2012). Furthermore, the primary agent for learning and developing the foundation for lifelong behaviours stems from the home environment (Caçola et al. 2015). Therefore, it is important that we start to understand what these influences are, how they have an impact on a child's MC development and, therefore, how parents, carers and educators can support their MC development. Is it what is done with the child, the equipment they have available, or the people around them that mostly influences their early development, or combination of such factors?

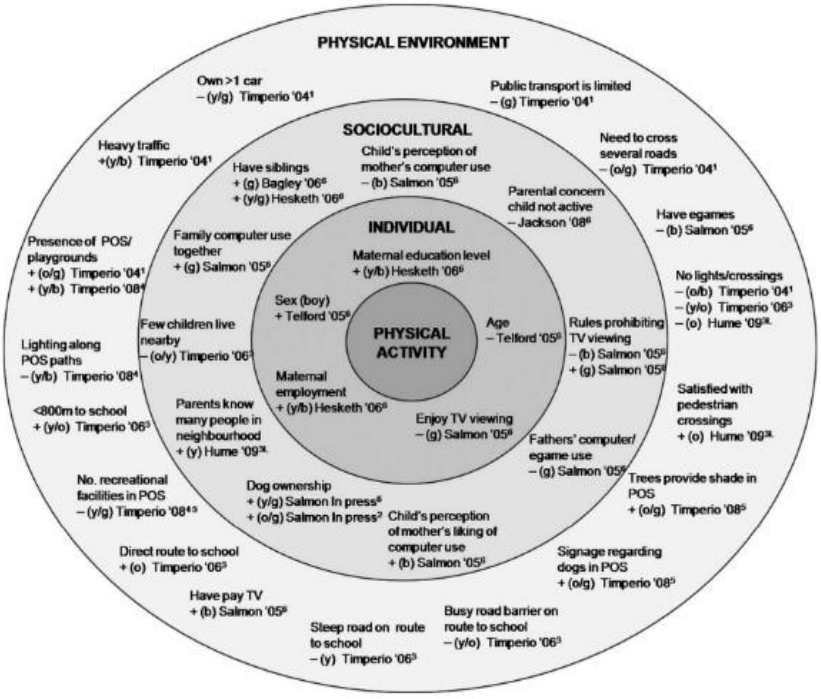

Figure 2. *Summary of significant socioecological variables from the CLASS/CLAN and HEAPS studies.* (Salmon, 2010)

Socio-Ecological Model of Behaviour

Research is needed to establish which correlates and determinants of MC could be targeted for optimal development of MC interventions and at which age the interventions should be implemented. The socio-ecological model of behaviours (Figure 1) provides a useful framework for examining layers of potential influence on MC, including individual (e.g., demographics, beliefs, and attitudes and active time), social (e.g., family demographics and influences) and physical environmental (e.g., availability of PA equipment and facilities) factors. The socio-ecological model of behaviour is therefore a useful tool as it allows there to be a focus on individual influences as well as on social and environmental factors that may contribute to or inhibit an individual's behaviour (Sallis & Owen, 1997). Ecological models postulate that behaviours have multiple levels of influence (e.g., intrapersonal, interpersonal, environmental and policy), thus gaining an understanding of the combination of psycho-social and environmental variables is best in explaining PA behaviour and MC development. This socio-ecological model has been used as a framework in other studies attempting to understand multiple and interrelated factors influencing PA behaviours in children within Physical Education (PE) contexts (e.g., Domville et al., 2019; Pawlowski et al., 2016).

Socio-ecological Factors and Motor Competency

Research into the behaviours of children in relation to their MC development has found limited evidence to support the contention that the acquisition of MC is influenced by a range of biological, psychological, social and environmental factors (Hardy, King, Farrell et al., 2010; Iivonen et al., 2013). Barnett et al. (2013) conducted a systematic review of 29 studies, examining determinants of MC in children (3-18 years). Age (increasing) was a correlate of children's motor competence. Weight status (healthy), sex (male) and socioeconomic background (higher) were consistent correlates for certain aspects of motor competence only highlighting the need for further research that considers the different layers. Iivonen and Sääkslahti's (2014) conducted a similar systematic review including 59 studies and additionally found that PA, and preschool-based programmes were positive determinants of MC in preschool-aged children. Both reviews highlighted that there have only been singular studies that have explored either the social environment or the physical environment, with few studies exploring determinants of MC from a holistic model of child development. Mutually the reviews found clear quantitative correlates relating to individual characteristics (biological and demographic factors), and limited evidence for the social and physical environment correlates. Furthermore, it was recommended that future research seeks to investigate which types of PA is of most importance to MC development (e.g., gymnastics, dance, swimming or more games related activities) or is it the amount of time active or frequency in the activity that has the most impact.

Socio-ecological Factors and Motor Proficiency

Previous studies have examined variables relevant to each of the layers of the socio-ecological model and explored their relationship with MP development. The majority of studies look at Gender, an individual level factor, was not associated with MP in many studies (Milanese, Bortolami, Bertucco, Verlato, & Zancanaro, 2010), particularly in relation to younger children (Du Toit and Pienaar, 2002; Shala, 2009; Venetsanou and Kambas, 2011). However, Duncan et al. (2020) found the rate of 'mastery' in each of the skills was higher for boys, as they are more competent at object control skills (Bolger et al., 2018; Hardy et al., 2013). Other studies have stated that the difference in scores could be attributed to stereotyped practices both within the school and home environment. Activities that facilitate the development of certain movement skills may be exposed traditionally more to boys than girls. For example, the gender influence on the selection of toys available to play with (Weisgram, Fulcher, & Dinella, 2014). Traditionally, boys are associated with being more likely to play with items such as sports equipment, whereas girls associated toys of choice were more likely to include dolls, fictional characters, and furniture (Pomerleau, Bolduc, Malcuit, & Cossette, 1990). The availability and exposure of these different types of gender-biased toys might contribute to the reported gender differences in MP, with boys playing more physical games than girls (Lindsey & Mize, 2001).

The role of ethnicity, another individual level factor, was reported by Eyre et al. (2018) to have a significant impact on young children's FMS, finding that South Asian children demonstrated poorer total skills, compared to Black and White children. Adeyemi-Walker et al. (2018) suggested that this is due to several interlinking factors: less opportunity for skills to be practiced and reinforced, social interactions, the influence of cultural norms/expectations, encouragement from others/role models, what their family/friends engage in, constraints in the community environment, the lack of open spaces, and the equipment available—as well as finances available for equipment and clubs/projects engagement (Logan et al., 2012; Morgan et al., 2013; Riethmuller et al., 2009; Sallis, et al. 2000, Van der horst et al. 2007).

In terms of environmental factors, Kretschmer et al. (2014) and Cools et al. (2010) found that general home environment factors were not directly associated with preschool children's FMS performance and less important than changes in lifestyle activities on the movement behaviour of children. This finding suggests that it is possible that more indirect factors such as how the parents deal with these conditions have a greater impact on children's opportunities to gain experience in FMS. In a cross-sectional study, Barnett et al. (2013) found that the number of pieces of skill-related equipment at home was positively associated with both locomotor and object control skills. The authors suggested that having a supportive environment, access to toys and equipment may help develop motor skill competence. Alternatively, also noted by Cools et al. (2011), children with better competence may be provided with more equipment, as parents tend to buy equipment more

frequently for their a more proficient child. Cools et al.'s (2011) review suggested that providing access to sport facilities creates an environment conducive to MC development. Furthermore, garden access was found to be a key correlate of FMS ability (both total FMS and object control), with studies identifying that lack of access to a suitably sized garden in the home environment was detrimental to the participation in PA and ultimately the development of movement skills within this population (Veitch, Salmon and Ball, 2010). However, Cools et al. (2011) found that the size of back yard did not show associations with the children's FMS performance. Nevertheless, a study by Burdette, Whitaker & Daniels (2004) found a moderate correlation between parental-report measures of outdoor playtime and direct measures of PA in pre-schoolers, highlighting the importance of outdoor play in preschool-aged children. More recently, Zeng et al. (2019) found that having PA equipment and/or play spaces present in the home was only positively related with locomotor skills. However, Honig (1999) and Kretschmer & Wirszing, (2008) argue that differences in the motor performance of children cannot be explained by the mere presence or absence of certain environmental conditions. These authors suggest that the way in which the children interact with the variables (e.g., equipment) is the critical factor. These authors suggest this interaction can be influenced by the child's gender and ethnicity and postulate that children actively decide in some way by themselves, whether the environment will be conducive or obstructive regarding their movement.

Socio-ecological and Motor Creativity

Research in the area of MCr is limited but it has been found that MCr is an independent trait from motor skill proficiency in five-to six-year-old children (Marinsek & Lukman 2021) and therefore needs to be considered separately. To be a more proficient performer in PA, children must develop a variety of complex movement patterns (Milić, 2014) and through divergent discovery style programmes children can became more fluent and flexible in producing movement patterns (Chatoupis, 2013). Little is known about what influences the development of MCr in young children and therefore how it can be encouraged.

Some research looking at creativity, not specifically MCr, in young people suggests that between the ages of three to about the age of five there is a gradual increase in imaginative behaviours (Klinger 1969). Indeed, Alsrour & Al-Ali (2014) found that older children (5-year-olds) had better imagination scores than younger children (3-year-olds), suggesting this individual factor may have a relationship with age. It is believed that social and environmental influences affect children as the 5-year-old children had lower fluency (different skills performed) scores than the 3-year-old children. At this age, children are more aware of others' directions, roles and the importance of meeting expectations of others. Younger children, who are in a critical period for physical growth, are more confident with their physical abilities. They love to run and climb up stairs. They will attempt to explore

the world physically. Studies looking at MCr tend to focus on either the cognitive or psychological issues (Carlota et al., 2021), the content and approaches to facilitating MCr development and its relationship with PA or MC (Richard et al., 2018, Karaca, Uzun & Metin, 2020). There is no known research into the correlates or affordances of MCr nor any studies considering the socio-ecological influences on a child's MCr development.

Aims and Objectives

The previous text has highlighted that young child are not meeting the recommended PA levels and that MC standards are low. Research is now focused on the why of both these issues and the how they can be addressed. MC includes the development of proficiency and creativity. To help parents and practitioners support children's MC development, there is a need to holistically examine factors that affect the child's development. The socio-ecological model allows there to be a focus on individual, social and environmental factors (Sallis & Owen, 1997), providing a holistic structure for possible variables and areas of focus. Therefore, the aim of this study was to identify individual, social and environmental factors that may explain the different levels of movement (proficiency and creativity) among 5-6-year-old children in a deprived area of England.

Methodology

Study Design

This study was designed as part of the SAMPLE-PE cluster randomised controlled trial (Rudd et al., 2020) and received ethical approval from the University Research Ethics Committee (17/SPS/031). The trial evaluated the effect of PE pedagogical approaches guided by motor learning theories on 5–6-year-old children's physical literacy (Rudd et al. 2020) (ClinicalTrials.gov identifier: NCT03551366). A cross sectional design using baseline data collected between January 2018 and March 2018 was employed.

Setting and Participants

Following University ethical approval, 29 schools assessed for eligibility were then approached to participate in the project. Headteachers from 12 of these schools then proceeded to give signed gatekeeper consent for recruitment and data collection. All schools were categorised as in areas of high deprivation, meaning that they are situated in areas ranked within the three most deprived deciles, as measured by the 2019 English Indices of Deprivation Index (Ministry of Housing Communities Local Government, 2019). All parent/carers and children from year one classes (aged 5-6 years old) were then invited to participate in the study (n=410) via an invitation pack, including information sheets, consent forms, parent and child characteristics questionnaire, child medical information form, and child assent form. In total, 360 out of 410 eligible children provided consent and were recruited to the project (88% response rate) for baseline assessments. Pupils with medical or additional needs where able to take part in the assessments but, along with any pupils that did not complete the consent requirements, where then excluded from the analysis.

Data collection procedures

Following parental/carer consent and child assent, parents/carers were invited to complete a questionnaire about their child which was sent home via the class teacher. The questionnaires were disseminated between January 2018 and March 2018 during baseline data collection for the SAMPLE-PE trial. Questionnaires were requested to be completed and returned to school for collection within 14 days. Alongside this, researchers visited the schools to conduct assessments of motor competence (motor proficiency and creativity) in participating children during school time.

Measures

Parental Questionnaire

The questionnaire was designed to capture information about the child and family and the child's PA experiences. The questionnaire was developed using items from previous research (Dowda et al 2011, McMinn et al 2009, Cools et al. 2010, Bagley, Salmon

& Crawford 2006, IPAQ 2005, Craig et al. 2009, Maddison 2007 (http://www.ipaq.ki.se/), Veitch, Salmon & Ball, 2010, Salmon et al 2004, McMinn et al. 2011). These items included individual, social and environmental correlates of PA and/ or motor competence. The final questionnaire is shown in Appendix 6.

Individual Level

Demographic information (10 items) about the child was collected including date of birth (decimal age), gender, and ethnicity, home postcode (to calculate index of multiple deprivation decile), country of birth, first language and age started at nursery (months). Both the mother and father's highest qualification was requested and scored in line with the English Government levels 1 = entry level – 8 = doctorate level (GOV.UK). Other individual level variables (4 items) included bespoke questions relating to the child's PA experiences and behaviours. Specifically, respondents were asked to proxy report the number of minutes of PA the child engaged in between the ages of 0-11.9 months, 1-2.9 years, 3-5 years, and an overall total volume of PA minutes was calculated for the 0-5 years. Furthermore (2 items), the number of PA clubs the child was currently attending both in school and extra-curricular since starting school was recorded. In addition (2 items), the parent's perception of their child's PA levels and coordination compared with that of other children, rated on Likert scales (1 much less – 5 much more) (Dowda et al 2011), and (1 item) their perception of their child's PA enjoyment (1 not enjoyable – 5 very enjoyable) (Dowda et al 2011). As well as statements (3 items) to evaluate the parents perception of their child's PA movement enjoyment (1 -strongly disagree – 5 strongly agree) (McMinn et al 2009). Finally, several questions (11 items) asked the parents to evaluate their child's personality (5 items) (1 -strongly disagree – 5 strongly agree) and child PA preferences (6 Items) (0=negative & 1= positive) (McMinn et al 2009).

Social Level

The influence of social factors on motor competence were explored including the family and home demographics (3 items), such as the number of adults living in the child's household (McMinn et al 2011) and whether the child's birth parents live together (Cools et al. 2010). The characteristics of siblings (10 items) both younger and older and whether they are at home or living elsewhere (Bagley, Salmon & Crawford 2006) was also captured. Parental attitudes and beliefs were also examined (1 item) such as whether the parent(s) think it is important that their child participants in PA/sports (McMinn et al 2009). In addition, the social support (5 items) received by the child and any PA rules (4 items) and PA barriers (10 items) (1 -never – 5 daily) set out for the child (Dowda et al 2011 & McMinn et al 2009). Parental PA behaviours (2 items) were self-reported by parents using the short form of the International Physical Activity Questionnaire (IPAQ) (http://www.ipaq.ki.se/), which has been shown to have acceptable test-retest reliability (r=0.8) and criterion-related validity,

compared with accelerometers (r=0.3), in adults in a 12-country evaluation study (Bergman et al. 2008). Daily minutes of leisure-time moderate PA and daily minutes of leisure-time vigorous PA were summed to provide a measure of moderate to vigorous PA (MVPA) for each parent. In addition, the parent/guardian reported (2 items) the enjoyment of PA for both mum and dad (1 not enjoyable – 5 very enjoyable).

Environmental Level

Environmental factors included questions about the average number of hours the child plays outside (4 items) in autumn/winter and spring/summer at the weekday or weekdays (0= not time – 5 more than 4 hrs) (Veitch, Salmon & Ball, 2010). In addition (3 items), whether outdoor space is available at home, and it is a suitable space for PA was also captured (0=negative & 1= positive) (McMinn et al. 2011) and totalled. Finally (14 items), the number of PA items available to the child at home and the frequency at which they are utilised (Salmon et al 2004) was explored (0=not presents, and if present 1-never played with – 5 played with very often).

Movement Competence

Movement competence was examined through a battery of assessments that both assessed technical movement proficiency and movement creativity across different domains (locomotor, object-control, and stability skills). All movement competence assessments took place in situ and during school hours in the school hall or playground and were filmed for analysis at a later date. Research assistants were trained prior to testing, and intra-rater and inter-rater reliability achieved using pre-coded videos to establish acceptable agreement, before analysis of video recordings was completed.

Movement Proficiency

Movement proficiency (technique) was assessed using the Test of Gross Motor Development-3 (TGMD-3) designed for use with children aged 3 to 10 year and with excellent intra-rater and inter-rater reliability (Maeng, Webster & Ulrich, 2016) and the Test of Stability Skills (Rudd et al., 2015) a process-based assessment tool to examine stability skills in children aged 6–10 years old with good face and content validity and inter-rater and test-retest reliability. Scoring criteria for TGMD-3 and the test of Stability Skills can be found in appendices 1 and 2, respectively. All 13 skills from the TGMD-3 were assessed for each participant, six ~~were assessed using the TGMD-3~~ locomotor (run, gallop, hop, skip, horizontal jump, slide) and seven object-control (two-hand strike, one-hand strike, one-hand dribble, two-hand catch, kick, overhand throw, underhand throw), taking 30 minutes in total. The Test of Stability Skills (15 min to complete) was utilised to measure proficiency of stability skills using three tasks (log roll, rock, back support). After the assessor had given

a verbal explanation and single demonstration each participant had one practice attempt before two trials of each skill.

Using the school's own hall, sports hall or outdoor space the TGMD-3 test was administered. Groups of 5-6 children, took the test at a time, taking approximately 45-60 minutes per group. A verbal explanation and a single demonstration were given to the group then each child had the opportunity of a practice attempt before completing two trials of each skill. Each attempt, including the practice, was recorded using a mounted video camera (Sanyo camcorder, Japan & tripod (1080p, 60fps)). Recordings of each skill were taken from the side of the performer, except for the bouncing skill, this was done face on. The video files were uploaded onto a secure university file to be evaluated later. A score of 0 or a 1 was awarded for each skill criterion depending on the task being correctly performed, (1) performed correctly or (0) performed incorrectly. Each skill was individually scored, based on its own three to five criteria (Appendix 1), for both trials. Once all criteria of each skill were scored the sum of each skill was obtained to create a total score.

The test of Stability Skills (Rudd et al., 2015), consisted of three individual gymnastics-based skills: the rock, log roll and back support (Appendix 2). Pupils were assessed in groups of 3, each group taking approximately 15 minutes to administer. The test was carried out in a suitably sized space in the school e.g., indoor school hall / sports hall or in a small empty classroom. At the start of each test the participants were each given a verbal explanation and a single demonstration of each skill. Each child then had the opportunity of a practice attempt before performing two trials of each skill to be assessed. Each attempt for each pupil was individually recorded for each skill, to be scored at a later date. The recordings were made using a tripod mounted video camera (Sanyo, Japan; 1080p, 60fps). Footage was recorded from a side on view for the rock and the back-support plank skills and then moved to capture a front on view for the log roll skill. The video files were uploaded onto a secure university file to be evaluated. A similar scoring system to the TGMD-3 was used for the test of Stability Skills. Likewise, each skill had its own set of individual criteria.

Movement Creativity

The Divergent Movement Ability Assessment (Cleland, 1990) was used to assess Movement creativity, the variety and diversity of movements. The test was selected as it was designed to measure range of movement of children aged four- eight years old (Cleland,1990) with sound test-retest reliabilities. In addition, r values were established for the locomotor play area task, the bench task, and the ballhandling task which values were 0.91, 0.94, and 0.93, respectively (Chatoupis, 2013). Validity was determined for content, design and analysis by six different professionals with doctoral degrees in the related fields of physical education (Cleland, 1994).

In groups of three, each child attempted one of three tasks then rotated around until all three tasks had been attempted. This took approximately 15 minutes for each group to complete all three stations. The circuit completed (appendix 4) included a stability skill station, a locomotor skill station and object control skill station. At the bench station (stability) each child was asked to make as many different shapes as possible on, around or in contact with the bench. At the locomotor station, each child was asked to find as many different ways to move around the obstacle course as possible. Finally, in the ball handling station (object control), each child was asked to play freely with a soft standard size 5 ball in the coned area. Each child had two 90s trials, with a predefined prompt from the research assistant to support and encourage the child every 30s. (Appendix 3). The assessments were carried out indoors in the pupils' own school hall or sports hall area. Each pupil and their attempts were recorded using a tripod mounted video camera (Sanyo, Japan;1080p, 60fps). At each station the camera was positioned to be able to capture the entire task area, whilst being close enough to capture the child's movements. The video files were uploaded onto a secure university file to be evaluated later. Each task station (locomotor, object control and stability) was scored individually for fluency and flexibility. A pre-set document of all possible actions and variations for each motor task was used to record each variation of movement (Appendix 3). Fluency was calculated by the total number of skill actions attempted (kicking a ball or bouncing the ball with hands). Flexibility was the number of different variations of actions (throwing a ball on one-hand or throwing the ball using two hands). A description of the DMA scoring can be found in Appendix 5.

Intra-rater and Inter-rater Reliability

All motor assessment assessors (n=4) were trained in advance of testing by two experienced researchers with ten and five-years of expertise in motor competence assessment, respectively. Training lasted for approximately 20 hours total, 10 hours for each set of assessments: MP (TGMD-3 and test of stability skills) and MCr (DMA). MP was assessed by four assessors and MCr by five assessors. Reliability for assessors were calculated for MP and MCr, Intra-rater (1-week test retest) and inter-rater in a sample of ten and nine children, respectively. Intraclass correlation coefficients (ICC) run with a two-way mixed, average measures for absolute agreement, with 95% confidence intervals.

Table 1 shows the inter- and intra-rater mean ICC scores for the four raters of the TGMD-3 (total locomotor and object control scores) and TSS (total stability scores), and the five raters of the DMA (total fluency and flexibility scores), as well as the mean range for each outcome ICC. All mean ICC scores were "excellent" (Cicchetti, 1994).

Table 1. *Inter and intra-rater means ICCs for all physical outcome measures*

Measure	Outcome measure	Inter-rater reliability Mean ICC (range)	Intra-rater reliability Mean ICC (range)
TGMD-3	Locomotor	.98 (.97 to .99)	.98 (.98 to .99)
	Object Control	.97 (.95 to .97)	.97 (.95 to .98)
TSS	Stability	.98 (.97 to .98)	.98 (.97 to .98)
DMA	Creativity (fluency)	.96 (.93 to .98)	.97 (.96 to .99)
	Creativity (flexibility)	.96 (.93 to .98)	.97 (.96 to .99)

Note. ICC = Intraclass Correlation Coefficient, TGMD-3 = Test of Gross Motor Development 3rd Edition, TSS = Test of Stability Skills, DMA = Divergent Movement Assessment

Statistical analysis

Only children who provided a completed parental questionnaire and completed all motor competence assessments were included in the final sample. Two dependent variables were created for analysis by totalling each participant's MP and MCr scores. Specifically, a total MP score was created by totalling the participants scores from the TGMD-3 (locomotor and object-control) and the test of stability skills. A total MCr score was created by totalling fluency and flexibility scores from each of the locomotor, object-control and stability stations.

IBM SPSS Version 26.0 (IBM Corp., Armonk, NY, USA) was used for the analyses, and the level of significance was set at $p < 0.05$. Descriptive statistics (mean and standard deviation (SD)) were calculated for all variables (Table 2), and an independent t-test was conducted to determine any gender differences for MP and MCr. Linear regression models were used to analyse the associations between the individual, social, and environmental factors and the two dependent variables: MP and MCr. Each model was adjusted for gender, given the evidence that gender differences exist in PA and MC (Stratton, Foweather & Hughes 2017, Webster et al. 2019 & Nilsen et al 2020). Initially, each of the individual, social and environmental variables were tested using Pearson correlations for bivariate associations with both dependent variables. Independent variables with correlations greater than 0.1 were carried forward for linear regression. Separate linear regression models were subsequently conducted for each of the continuous dependant variables (movement proficiency and movement creativity) to examine each level of socio ecological predictors (individual, social, environmental). Inspection of model's residuals confirmed that they were normally distributed, and the assumptions of the analysis had been met.

Results

Descriptive statistics

Of the 360 children from twelve schools that provided consent and were recruited to the project, 119 children across 10 schools returned the parental questionnaires. Nineteen of these children had missing MCr and MP data and were therefore excluded from the analysis. Missing questionnaire data was due to one school not handing out the questionnaires, non-responses, or incomplete returns. Reasons for the missing motor competence data included lack of availability of schools for scheduling data collection time, lack of time to complete assessments, no video recording of child performances captured or children being absent from school on the days of testing. The final sample for the project therefore included 100 children aged 5-6 years (Mean age 6.02 years, SD 0.32; Male 50%).

Descriptive statistics of the final sample are shown in Table 2. The majority of the sample were White British (60%) with 40% classified as Other (i.e. white not British 5%, Mixed/Multiple Ethnic groups 9%, Asian 14%, Black African/Caribbean/British 8%, Arab 3% and other 1%). With the majority of the cohort (85%) being born in the UK and 81% speaking English as their first language. Most children (81%) lived in a neighbourhood rated as amongst the 30% most deprived in the country, of which 62% children lived within an area within the highest decile for deprivation.

Table 2. *Descriptive Statistics for all variables.*

	Group			Boys			Girls		
	n=100			***n=50***			***n=50***		
	n	**% or Mean**	**SD**	**n**	**% or Mean**	**SD**	**n**	**% or Mean**	**SD**
Individual Demographics									
Decimal age (years)	100	6.0	0.4	50	6.0	0.3	50	6.0	0.4
Index of multiple deprivation decile	99	2.1	1.8	50	2.0	1.6	49	2.2	2.0
The child was born in UK or not	100	85.0%		50	88.0%		50	82.0%	
First language English	100	81.0%		50	86.0%		50	76.0%	
Mother highest qualification	88	4.3	2.2	43	4.3	2.1	45	4.4	2.2
Father highest qualification	78	4.0	2.4	38	4.0	2.4	40	4.0	2.6
Individual									
Age started nursery (months)	98	29.1	13.0	49	29.1	13.4	49	29.0	12.7
Total activity 0-11.9 months (minutes)	100	526.1	1553.6	50	317.5	726.1	50	734.6	2064.2
Total activity 1-2.9 years (minutes)	100	956.1	2761.5	50	1089.9	2972.3	50	822.4	2556.7
Total activity 3-5 years (minutes)	100	3079.8	5504.1	50	3082.0	5546.9	50	3077.5	5517.2
Total activity 0-5 years (minutes)	100	4662.0	8021.1	50	4689.5	7807.2	50	4634.5	8308.7
Total No. school clubs	100	1.0	1.5	50	1.1	1.3	50	1.0	1.7
Total No. out of school clubs	100	0.8	1.0	50	0.6	0.8	50	0.9	1.1
Combined total in & out school clubs	100	1.8	1.9	50	1.7	1.7	50	1.9	2.2
PA levels compared with other children	99	3.6	0.9	49	3.6	0.8	50	3.6	0.9
Co-ordinated compared with others	99	3.5	0.8	49	3.4	0.8	50	3.6	0.8
PA enjoyment levels	99	4.4	0.8	49	4.3	0.9	50	4.5	0.7
Child PA movement enjoyment	99	13.2	2.1	50	13.3	2.1	49	13.2	2.2
Child personality	98	19.0	2.8	50	19.3	2.6	48	18.7	3.0
Child activity preference	89	4.3	1.2	44	4.2	1.3	45	4.4	1.1
Social									
Total number of adults at home	98	2.1	0.7	49	2.0	0.6	49	2.1	0.7
Total number of parents at home	98	0.9	0.5	49	0.9	0.5	49	0.8	0.4
Do birth parents live together at home	98	79.0%		49	70.0%		49	84.0%	
Single Parent household	98	17.5%		49	24.0%		49	10.0%	
Child lives with a birth and stepparent	98	2.0%		49	2.0%		49	2.0%	
Total No. of younger siblings	98	0.4	0.6	49	0.5	0.6	49	0.4	0.6
Total No. of older siblings	98	0.6	1.0	49	0.5	1.0	49	0.7	0.9
Total No. of siblings	99	1.1	1.1	50	1.0	1.2	49	1.1	1.0
Parent think child PA/sports important	99	4.7	0.6	50	4.8	0.4	49	4.6	0.8
Social support	99	20.0	3.5	50	20.2	3.1	49	19.7	3.9
PA rules	99	9.2	3.4	50	8.8	3.6	49	9.7	3.2
PA barriers	97	19.3	6.5	48	19.4	6.7	49	19.2	6.4
Mum total met minutes week	80	2975.3	2993.6	37	3194.1	2955.6	43	2787.1	3048.0
Dad total met minutes week	71	3849.3	3245.1	33	4397.0	3484.4	38	3373.7	2987.2
Mums' enjoyment of PA	88	3.6	1.1	41	3.5	1.1	47	3.7	1.2
Dads' enjoyment of PA	75	4.2	1.0	35	4.3	1.0	40	4.1	1.1

Environmental									
Average child plays outside:									
Autumn/winter weekday (hours)	92	1.3	0.8	47	1.2	0.7	45	1.3	0.9
Autumn/winter weekend (hours)	94	2.4	1.2	47	2.5	1.2	47	2.4	1.2
Spring/summer weekday (hours)	94	2.5	1.1	47	2.5	1.1	47	2.5	1.1
Spring/summer weekend (hours)	95	4.1	1.1	48	4.2	1.1	47	4.0	1.2
Total outdoor play year (hours)	92	10.3	3.4	47	10.5	3.3	45	10.2	3.6
Average outdoor play (hours)	92	2.6	0.9	47	2.6	0.8	45	2.6	0.9
Outdoor space at home	98	2.0	1.2	49	1.9	1.2	49	2.0	1.2
Number of PA items at home	98	8.7	4.2	49	8.6	4.6	49	8.9	3.8
Total frequency of usage of PA items	98	23.6	10.5	49	21.3	9.0	49	25.8	11.5
Motor creativity measures									
DMA Locomotor total score	100	21.4	9.0	50	21.7	10.0	50	21.0	8.0
DMA Object control total score	100	25.9	9.6	50	26.4	10.1	50	25.4	9.2
DMA Stability total score	100	9.6	8.2	50	8.1	8.0	50	11.0	8.3
DMA Fluency total score	100	20.9	7.1	50	20.4	7.1	50	21.3	7.2
DMA Flexibility total score	100	36.0	14.3	50	35.8	15.1	50	36.1	13.6
DMA Motor Creativity total score	100	56.8	21.0	50	56.2	21.5	50	57.4	20.6
Motor proficiency measures									
TGMD Locomotor total score	100	27.7	5.7	50	27.6	6.0	50	27.8	5.4
TGMD Object control total score	100	26.5	7.8	50	29.3	8.5	50	23.7	5.9
TGMD total	100	54.2	10.6	50	56.9	11.8	50	51.5	8.5
Stability Total	100	8.2	3.8	50	7.9	3.9	50	8.5	3.8
Motor proficiency total	100	62.4	12.5	50	64.8	13.9	50	59.9	10.6

Notes. PA = Physical Activity, TGMD = Test of Gross Motor Development-Third Edition, DMA= Divergent Movement Ability

Means from Table 2 show boys' proficiency was on average higher than the girls, whilst girls on average scored higher in stability, boys had higher TGMD locomotor and object control scores. The girls mean average scores for creativity were higher than the boys. Despite the boys scoring slightly higher on average in the DMA locomotor and Object control score, the girl's stability scores were higher. Two independent sample t-tests were performed to compare both MP and creativity in boys and girls. There was no significant gender differences in MP total score ($t(98) = [-1.971]$, $p = 0.52$), or MCr total score ($t(98) = [.290]$, $p = 0.77$).

Correlations between individual, social and environmental variables and motor proficiency and motor creativity

Correlations between individual (Table 3), social (Table 4) and environmental (Table 5) variables with MP and MCr are shown below.

Motor Proficiency

At the individual level, a significant positive weak correlation was found between decimal age and MP (r=.21, p=.037). Gender showed a small positive correlation with MP (r=.20, p=.052), indicating that being male was associated with higher levels of proficiency. Whether the country the child was born in is the UK or not (UK scored^) had a fair positive correlation with proficiency (r=.14, p=.169), while if the child's first language was English (English^) there was a weak positive correlation in relation to proficiency (r=.12, p=223) but showed no significance. Whether the parent considered that the child was coordinated compared with others showed a weak positive correlation with proficiency (r=.20, p=.051) and was near significance. No other individual level correlations of at least fair magnitude were observed (i.e., r >= 0.1).

At the social level, the amount of social support given to the child showed a weak correlation with proficiency (r=.10, p=.321). The Mum's total metabolic minutes in PA was weakly and negatively correlated with proficiency (r= -.12, p=.277). The Dad's enjoyment of PA (5 enjoyable) also had a weak negative correlation with proficiency (r= -.10, p=.393). If the parent/carer completing the questionnaire thought PA was important there was a weak negative correlation with proficiency (r=-.11, p=.279). No other social level correlations of at least fair magnitude were observed (i.e., r >= 0.1).

At the environmental level, if the child played outside in the autumn on a weekday had a weak positive correlation with proficiency (r=.13, p=.231). No other environmental level correlations of at least fair magnitude were observed (i.e., r >= 0.1).

Motor Creativity

At the individual level, ethnicity had a small negative correlation with MCr (r=-.14, p=.166) (White British = 1). The child's ethnicity code (1= white British; 2=non-white British) showed a negative weak correlation with MCr (r=-.23, p=.023), indicating that non white British children performed better. Whilst the child's Index of multiple deprivation showed a weak positive correlate (r=.16, p=.121), indicating that a child from a lower postcode decile would be less likely to score as well. Whether the country the child was born in is the UK or not (uk^) showed a positive moderate correlation with MCr (r=.30, p=.003), indicating that a child born in the UK was more likely to have better MCr than those not born in the UK. Further correlations showed if the child's first language was English (English^), there was a moderate positive correlation with MCr (r=.36, p=<.001). The child's father highest qualifications had a positive weak correlation with creativity (r=.14, p=.234), indicating that children with educated fathers had a slightly more chance of scoring better on MCr. The age at which the child started nursey correlated negatively (r=-.11, p=.288) with MCr, suggesting the older they start the lower their MCr. The total number of minutes of PA that were accrued between 1-2.9 years of age was negatively and weakly correlated with creativity (r=-.13, p=.184). Whereas, the child's total PA minutes between 3-5 years showed

a weak positive correlation with creativity (r=.13, p=.192). Indicating that PA between the ages 1-2.9 did not contribute to the child's creativity, and possibly hindered it, whilst PA between 3-5 years made a small contribution to the child creativity. The number of PA clubs attended in school showed a weak positive correlation with creativity (r=.13, p=.190) indicating that participation in PA clubs could improve the child's creativity. The number of combined PA clubs in and out school also showed a weak positive correlation with creativity (r=.13, p=.187) indicating that attendance at clubs out of school as well may contribute to developing a child creativity. Is this telling us the out of school clubs aren't as effective? Finally, the child's movement enjoyment had a weak positive correlation with creativity (r=.11, p=.267) indicating that if the child enjoys movement, they are more likely to be more creative.

At the social level, the child's birth parents living together showed a significant positive correlation with creativity (r=.20, p=.048) and if the child's household was that of a single parent there was a significant negative correlation with creativity (r=-2.15, p=.035). Indicating that a child living with both parents will develop better creativity than a child living with a single parent whose creativity will be less than expected. The number of older siblings correlated weakly positive with the child's creativity (r=.12, p=.224) as did the total number of siblings show a weak positive correlation with creativity (r=.12, p=.225) indicating children who have older or more siblings will have developed better levels of creativity than a child who has fewer and younger siblings. The Mums total metabolic minutes weakly and negatively correlated with creativity (r=-.13, p=.250) indicating that if the child's mum is more physically active over the week this hinders their creativity. Finally, if the parent/carer completing the questionnaire thought PA was important there was a weak negative correlation with creativity (r=-.19, p=.063) indicating that the child's creativity wasn't improved if the parent valued PA in fact, it may be hindered.

At the environmental level, if the child played outside in the autumn on a weekday (r=.126, p=.231) and the amount of outdoor space the child has at home showed a weak positive correlation with creativity (r=.135, p=.185), but neither were significant. This indicates that space and environment didn't appear to individually influence movement creativity.

Table 3. *Correlations between individual level variables, motor proficiency and motor creativity*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
MP		**.32****	**.21***	**.20**	.07	.07	**.14**	**.12**	.04	.00	.07	.04	-.02	.05	.04	.04	-.01	.03	.00	**.20**	-.02	.07	.05	.07
MCr			.09	-.03	**-.23***	**.16**	**.30****	**.36****	.05	**.14**	**-.11**	-.01	**-.13**	**.13**	.03	**.13**	.06	**.13**	.05	.06	.03	**.11**	.04	.02

Notes. 1.Motor proficiency total MP 2. Motor Creativity total MC 3.Decimal age 4.Gender 5.Ethnicity 6.Index of multiple deprivation decile 7.The child was born in UK or not 8.First lang English 9.Mother highest qualification 10.Father highest qualification 11.Age start of nursery 12.Total activity mins under 11.9 months 13.Total activity mins 1-2.9 years 14.Total activity mins 3-5 years 15.Total activity mins 0-5 years 16.Total No. sch clubs 17.Total No. out of sch clubs 18.Combined-total in & out school 19.PA levels compared with others 20.Coordinated compared with others 21.Child PA enjoyment levels 22.Child PA movement enjoyment 23.Child personality 24.Child activity preference

*** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Bolded font = correlation magnitude r >= .01*

Table 4. *Correlations between social level variables, motor proficiency and motor creativity*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
MP		**.32****	-.05	.04	-.01	.02	.01	.04	.03	**.10**	-.03	-.01	**-.12**	.07	.02	**-.10**	**.11**
MCr			.03	**.20***	**-.22***	-.00	.00	**.12**	**.12**	.05	.07	-.05	**-.13**	-.04	-.04	-.02	**.19**

Notes. 1.Motor Proficiency total MP 2. Motor Creativity total MC 3. Total No. of adults at home 4. Do the birth parents live together 5. Single parent household 6. Child lives with a birth & stepparent 7.No. of younger siblings 8. No. of older siblings 9. No. of siblings 10. Social support 11.PA rules 12.PA barriers 13. Mum total met minutes week 14. Dad total met minutes week 15. Mums enjoyment of PA 16. Dads enjoyment of PA 17. Parent think PA/sports is important for child

*** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed). Bolded font = correlation magnitude r >= .01*

Table 5. *Correlations between environmental level variables, motor proficiency and motor creativity*

	Motor Proficiency	Motor Creativity
Average child plays outside autumn/winter w/d	**.13**	.07
Average child plays outside autumn/winter w/e	-.00	.07
Average child plays outside spring/summer w/d	.02	.09
Average child plays outside spring/summer w/e	.01	.08
Total outdoor play year	.04	.09
Average outdoor play	.04	.09
Outdoor space at home	.01	**.14**
Number of PA items at home	.04	-.08
Total frequency of usage of PA items	-.06	-.01

~~** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).~~
Bolded font = correlation magnitude r >= .01, *PA = Physical Activity, w/d-weekday, w/e-weekend*

Regression models examining socio-ecological predictors of movement competence

Linear regression models were used to examine whether selected independent variables (r=≥0.1) from each level of the socioecological model (individual, social or environmental) predicted MP and MCr, and the level of variance explained by each socio-ecological model level.

Motor Proficiency

No significant associations were found between individual level variables and MP (Table 6). The overall regression model was not statistically significant (F=1.119, p=.361), with R^2 of 0.19.

The associations between social level factors and MP are shown in Table 7. Social factors were found to account for 9% (R^2=0.9) of variance in MP, however the model was not significant (F=0.530; p=.846*)*. No significant associations were found between social level factors and MP.

Table 8 shows associations between environmental factors and MP. No significant associations were found, and the model was not significant (F=1.914, p=.133), with R^2 of 0.062.

Table 6. Associations between individual level factors and motor proficiency

		β	SE β	*p* value	LCI	UCI
1	(Constant)	7.32	28.36	0.797	-49.4	64.0
	Gender	5.40	2.79	0.057	-0.2	11.0
	Age	6.27	4.34	0.154	-2.4	15.0
	Ethnicity	-2.27	4.03	0.575	-10.3	5.8
	Index multiple deprivation decile	0.96	0.75	0.204	-0.5	2.5
	The child was born in UK or not	3.07	4.58	0.505	-6.1	12.2
	First language English	0.17	4.73	0.972	-9.3	9.6
	Total activity minutes 1-2.9 years	0.00	0.00	0.722	0.0	0.0
	Total activity minutes 3-5 years	0.00	0.00	0.286	0.0	0.0
	Total no school clubs	2.44	1.86	0.195	-1.3	6.1
	Combined total in & out school	-0.89	1.61	0.582	-4.1	2.3
	Coordinated compared with others	0.56	1.94	0.774	-3.3	4.4
	Child PA movement enjoyment	0.13	0.88	0.885	-1.6	1.9
	Father highest qualification	-0.29	0.65	0.663	-1.6	1.0

Note:β, unstandardized regression coefficient; Seβ, standard error for β coefficient; LCI & UCI, Lower and upper confidence intervals for regression coefficient; model controlled for gender, PA = Physical Activity

Table 7. Associations between social level factors and motor proficiency

		β	SE β	*p* value	LCI	UCI
1	(Constant)	32.82	21.85	0.139	-11.06	76.69
	Do the birth parents live together	5.92	8.63	0.496	-11.39	23.24
	Does the child live in a single parent house	-3.34	9.40	0.724	-22.20	15.53
	Total number of older siblings	-1.16	3.37	0.733	-7.93	5.61
	Total number of siblings	0.89	3.15	0.779	-5.43	7.21
	Social support	0.41	0.47	0.384	-0.53	1.36
	Mum total met minutes per week	0.00	0.00	0.624	0.00	0.00
	Dad enjoyment of PA	-1.98	1.79	0.274	-5.58	1.61
	Parent thinks Childs PA is important	3.50	3.96	0.381	-4.44	11.44

Note:β, unstandardized regression coefficient; Seβ, standard error for β coefficient; LCI & UCI, Lower and upper confidence intervals for regression coefficient; model controlled for gender, PA = Physical Activity

Table 8. Associations between environmental level factors and motor proficiency

		β	SE β	*p* value	LCI	UCI
1	(Constant)	52.13	5.43	0.000	41.33	62.93
	average child plays outside autumn/winter w/d	2.14	1.7	0.211	-1.24	5.52
	outdoor space at home	-0.05	1.14	0.967	-2.32	2.23

Note:β, unstandardized regression coefficient; Seβ, standard error for β coefficient; LCI & UCI, Lower and upper confidence intervals for regression coefficient; model controlled for gender, *w/d-weekday*

Motor Creativity

Table 9 shows the results of the linear regression model examining associations between individual level factors and MCr. The overall model showed statistical significance with the selected individual level factors accounting for 34.1% of variance in MCr (F (13,62)= 2.467, p=.009), with R^2 of .341. A significant positive association was found between MCr and the Index of multiple deprivation decile (β=2.872, p=0.034), indicating that a child from a lower area of deprivation was likely to score lower in creativity. The child's total time active (minutes) between 3-5 years (β = 0.001, p=0.032) also showed significant positive association with MCr eluding that participation in more PA between this age increased creativity. A significant but weak negative association was found between MCr and the amount of time (minutes) the child was physically active between 1 to 2.9 years (β =-0.002, p=0.022), indicating that more PA at this age was potentially negatively impacting on the development of creativity. No other significant associations were observed.

No significant associations were found between any of the social level variables and MCr (Table 10). The social level model was not significant (F=0.476, p=.884), with R^2 of .085.

No significant relationships were found in the environmental model for MCr (Table 11). The model was not significant (F=0.41 p=.746) with R^2= .014.

Table 9. Associations between individual level factors and motor creativity

		β	**SE β**	***p* value**	**LCI**	**UCI**
1	(Constant)	-29.88	50.24	0.554	-130.32	70.55
	Gender	-2.71	4.94	0.585	-12.59	7.17
	Age	11.07	7.70	0.155	-4.32	26.45
	Ethnicity	-6.15	7.15	0.393	-20.44	8.14
	Index multiple deprivation decile	**2.87**	1.33	**0.034**	0.22	5.53
	The child was born in UK or not	14.20	8.12	0.085	-2.03	30.44
	First language English	9.69	8.38	0.252	-7.05	26.43
	Total activity minutes 1-2.9	**0.00**	0.00	**0.022**	0.00	0.00
	Total activity minutes 3-5	**0.00**	0.00	**0.032**	0.00	0.00
	Total no school clubs	4.53	3.29	0.174	-2.05	11.11
	Combined total in & out school	-2.12	2.85	0.461	-7.82	3.59
	Coordinated compared with others	-4.11	3.43	0.236	-10.97	2.76
	Child PA movement enjoyment	-0.82	1.55	0.600	-3.91	2.28
	Father highest qualification	1.90	1.16	0.106	-0.41	4.22

Note:β, unstandardized regression coefficient; Seβ, standard error for β coefficient; LCI & UCI, Lower and upper confidence intervals for regression coefficient; model controlled for gender PA = Physical Activity, *Bold font = p value < .005*

Table 10. Associations between social level factors and motor creativity

		β	SE β	*p* value	LCI	UCI
1	(Constant)	-4.92	38.26	0.898	-81.73	71.89
	Birth parents live together at home	1.67	15.10	0.913	-28.65	31.98
	The child lives in a single parent house	-1.17	16.45	0.943	-34.20	31.86
	Total number of older siblings	-0.71	5.90	0.905	-12.56	11.14
	Total number of siblings	0.87	5.51	0.876	-10.20	11.93
	Social support	0.47	0.83	0.568	-1.18	2.13
	Mum total met minutes mins week	0.00	0.00	0.773	0.00	0.00
	Dad enjoyment of PA	-1.79	3.13	0.571	-8.08	4.51
	Parent thinks Childs PA is important	12.32	6.92	0.081	-1.58	26.22

Note:β, unstandardized regression coefficient; Seβ, standard error for β coefficient; LCI & UCI, Lower and upper confidence intervals for regression coefficient; model controlled for gender PA = Physical Activity

Table 11. Associations between environmental level factors and motor creativity

		β	SE β	*p* value	LCI	UCI
1	(Constant)	51.72	9.34	0.000	33.17	70.28
	Avg. child plays outside autumn/winter w/d	1.96	2.92	0.505	-3.85	7.77
	Outdoor space at home	1.82	1.97	0.357	-2.09	5.73

Note:β, unstandardized regression coefficient; Seβ, standard error for β coefficient; LCI & UCI, Lower and upper confidence intervals for regression coefficient; model controlled for gender

Discussion

This study aims (pg.17) were to explore associations between socio-ecological factors and MC amongst 5–6-year-old children from deprived areas of North-West England. Using the socioecological model (pg.13) to identify individual, social and environmental factors that may explain the different levels of movement (proficiency and creativity) among 5-6-year-old children in a deprived area of England.

This study is the first to explore associations between socio-ecological variables of both MP and MCr amongst children living in areas of high deprivation. It is one of few studies to look at motor creativity in young children and consider its role in motor competence development.

The findings from this study suggest that the most significant level of socio-ecological influence are at the individual level, but in relation to MCr only. Specifically, deprivation decile, total amount of PA minutes between the ages 1 to 2.9 years and 3 to 5 years were significantly associated with MCr in this sample. None of the factors from the social or environmental layers were found to have any significant effect on either MP or MCr in this group of 5–6-year-olds living in deprived communities.

Socio-ecological Factors Affecting Motor Proficiency

Individual Level

No significant associations were identified between individual, social or environmental factors and MP. Several individual level variables showed fair relationships with total MP scores in bivariate correlations (i.e., age, gender, UK born, first language English, Co-ordinated compared with others). However, there were no significant associations observed in the regression models, and the regression models were not significant. The model estimates did suggest that with every year older the children are likely to have a higher proficiency score ($\beta = 5.399$), but this was not a significant ($p=.154$). It has been found in other studies that older children are more likely to participate in more MVPA (Pfeiffer et al., 2009) contributing to their development of motor skill development and that age (increasing) has been found to be a correlate of children's motor competence (Barnett et al., 2016). This may not have been evident in this study due to the narrow age range and small sample size and already low levels of MP measured. It would be a suggestion for similar studies to consider a larger sample that might capture a wider age range and also diverse MP levels.

The present study found no association between gender and MP. This is similar to other studies, who have also reported no gender difference (Milanese, Bortolami, Bertucco, Verlato, & Zancanaro, 2010), particularly in relation to younger children (Du Toit and Pienaar, 2002, Shala, 2009, Venetsanou and Kambas, 2011). However, this contrasts with many studies in this area that have found that gender is a correlate of children's MP within different domains. With studies favouring boys to score higher than girls (Stratton 2017 &

Adeyemi-Walker, Duncan, Tallis, and Eyre, 2018), specifically on object control skills (gross motor skills) including catching and dribbling, etc. (Morley et al 2015), and girls scoring higher than boys on locomotor skills and stability (Livonen, and Sääkslahti, 2014, Navarro-Patón et al 2021). Conversely, Barnett et al's. (2016) systematic review of correlates of motor competence summarises that the association between composite skill scores for boys is indeterminate, and there is no evidence that the sex of a child is associated with locomotor competence. Nor is there consistent evidence for "being female" as associated with stability. It appears that the role gender plays in MP development is still unclear and further research is required. From this study it suggests that there is a need for further consideration of skill domain, e.g. locomotor skills, rather than composite scores when examining associations between gender and MP.

While associations between deprivation and MP were not evident in this study, this is in line with reviews from Cools et al. (2011) and Barnett et al. (2016), which also reported inconsistent findings in this regard. However, Booth et al. (2006), using postcode as the SES indicator, found a relationship between higher skill proficiency with higher socioeconomic status. Some studies have found a positive and consistent relationship between SES and MP among girls (Booth et al. 1999 & Foulkes et al. 2015), but the same relationship has not always been found to be as consistent for boys. It is likely that associations between SES/deprivation and MP were not identified in this present study as all participants were recruited from lower SES areas. Moreover, Cools et al. (2011) stated that the outcome of this area of study does seems to be highly dependent on the factors used to estimate family socioeconomic status. In addition, the majority of the previous studies have used correlations and not regressions in their analysis, making direct comparison of results questionable. It may be that the sample in this study did not include a sufficient diverse enough range of children in terms of age or deprivation to find associations with MP. Future studies looking at MP should continue to consider SES status as well as looking at genders separately in relation to the variables. The effect of age should also be considered to clarify if this is a contributing factor.

In addition to the individual factors mentioned above, there was no association found between MP and the child being born in UK (85%) or that their first language was English (81%). This is similar to Eyre, Walker, and Duncan (2018), who also reported no relationship for native English speakers with MP, in contrast to previous studies that have found boys from non-English-speaking backgrounds had lower FMS competency (Hardy et al., 2012). In addition to this, Eyre, Walker, and Duncan (2018) also reported the role of ethnicity to have significance impact on young children's FMS, finding that White and Black ethnic backgrounds scored higher than South Asian particularly locomotor skills. The lack of similar findings or association in this study, may again, be in relation to the sample being small and lacking diversity across the group. Future studies in this area would benefit from a larger sample to get a better cross-section of scores.

Analysis of the time spent in PA in the present study did not find any association between PA participation from ages 1- to 3-years-old or 3- to 5-years-old with MP. This finding is consistent with those from the Barnett et al. (2022) recent systemic review that found insufficient evidence across 11 studies that investigated PA as a pathway to MC, and contradicts the hypothesis of Stodden et al. (2008). Other studies have found a positive relationship between PA and motor skill proficiency in young children (Iivonen & Sääkslahti, 2014; Zeng et al., 2017, Figueroa & An, 2017. Hall, Eyre, Oxford & Duncan 2018). Jones et al's. (2020) systematic review and meta-analysis reported a positive association between motor competence (FMS) and PA and Total physical activity (TPA) in young children from 19 studies. Most of these studies were in the preschool setting and all used object measures, ActiGraphs and accelerometers, to gather their PA data, unlike this study which relied on parental recall of PA time once the child had started school, perhaps reducing the validity and reliability of the responses given. A recent regression study by Niemistö et al. (2020) found that participation in organised sports was associated with better MC score. In contrast to the findings in this study, they also found that during early childhood, motor development did benefit from PA related hobbies (Lubans, 2010., Niemistö, 2019., Queiroz, 2014.), though there may be differences between environments (Niemistö, 2019.) and countries (Laukkanen et al., 2019). In addition, it should not be forgotten as to the importance of outdoor play and everyday life choices (Laukkanen et al., 2019.) that help to contribute to more daily PA. The associations between structured activity participation and MP differs according to the nature of the activity indicating the importance of the actual activity context to detect associations with motor skill type (Barnett, Hinkley, Okely and Salmon 2013). Future studies should seek a more longitudinal approach to monitor PA over the early years, and record more accurate data in relation to types and intensities of activity to make more informed analysis of the impact of PA on MC development.

The present study did not find any association between the child's parent's highest academic qualifications and MP. Similarly, Ferreira et al. (2006) found no evidence to support a link to between child PA levels with parental education. Nevertheless, the present study findings appear to contrast with the majority of studies that have found that parental education was positively associated with their child's FMS performance (Cools 2011), and that a child's locomotor skills are linked with higher parental education. Giagazoglou et al. (2007) found specific associations with children of highly educated mothers scoring higher on both locomotor and eye-hand coordination scales. Both studies suggesting the higher educated the parent the more interactions they are likely to have with their child and are more likely to encourage them to engage in activities outside (Zeng et al., 2019). This was not apparent in the current study but could be due to the classification of education, other studies tend to band qualifications (low, middle, high) into levels rather than keep each one separate as we did (1-8); grouping education levels into smaller categories like tertiles may have led to a stronger association with MP.

Social Level

No social factors were significantly associated with MP. Similar to Zeng et al. (2019), Barnett, Hinkley, Okely and Salmon (2013) and Niemistö (2020), this study found no association between home demographics, parental perceptions of physical competence and MP, nor Parental PA. In contrast to these findings, Cools et al. (2011) reported Parental PA as a determinant of FMS in boys and also found that parental importance of PA was a determinate of FMS competency in both genders. This study used the Motoriktest fur Vier- bis Sechsjahrige Kinder (MOT 4–6) test and not the TGMD. Previous comparisons of these two tests have shown low-to-moderate correlations suggesting the TGMD and KTK may measure different aspects of MC (Ré et al. 2018).

Environmental Level

No environmental level factors were significantly associated with MP, similar to previous research (Kretschmer et al., 2014; Cools et al., 2010). It is suggested that the general living environment was less important than changes in lifestyle activities on the movement behaviour of children (Kretschmer et al., 2014) and more indirect factors such as parental involvement and guidance in and around the environment have a greater impact on children's opportunities to gain experience in FMS (Cools et al 2010). Parents providing more opportunities, equipment and access to an environment to be active is more important (Cools et al. 2011). As stated previously, Honig (1999) and Kretschmer & Wirszing (2008) argue it cannot be the mere absence of certain environmental conditions but interaction with the variables which play a key factor. This interaction has been found to be impacted by both gender and ethnicity group, or a combination. Previous research reports that the child actively decides by themselves, whether the environment will be conducive or obstructive regarding their movement. It has been suggested that as a child ages family and environmental factors may become of more importance (Stodden et al. 2008) the relationship between individual, family and environmental constraints will compound and relate more strongly over time to movement skill competence and PA behaviour. Therefore, the impact of their environment at a young age is not as impactful and why this study and other studies of children this age did not find any associations.

Socio-ecological Factors Affecting Motor Creativity

Individual Level

Across the layers of the socioecological model only variables at the individual level showed any significance with MCr in the regression models. Significant positive associations were observed between MCr and the child's index of multiple deprivation decile and activity minutes accrued between ages 3-5 years, while a significant negative association was found between activity minutes accrued between the ages 1-2.9 years.

Castillo-Vergara et al. (2018) also found that as socioeconomic level increased, so did creative ability. This can be linked to the idea that children in higher socioeconomic households have more educated parent/carers therefore better role modelling/parental support. A more educated parent potentially has a better paid job and can typically afford a house with more space to play and provide access to more equipment. However, MCr did not appear to correlate with the social and environmental variables considered in this study and was not evident at the other levels of the model. Interestingly, the amount of time the child spent in PA between the ages 1-2.9 appeared to have a negative effect on creativity, suggesting in this case that participation in organised sport or PA sessions at this age was detrimental to the child's creativity. It is not clear whether the structured nature of PA that was captured by parent proxy in the current study hinders MCr or perhaps that the activities children were engaging in during these structured activities were not conducive to the development of MCr. MCr research suggests that a young child's creativity can be influenced by early experiences in dance and movement education (Hanson, 1992; Lubin, 1978; Sherrill, 1986). The current study did not look at the *types* of PA activity, only the amount in minutes. Therefore, future research may wish to examine the type and quality of previous PA. Further attention in data collection of types of activities and intensities would allow for comparison between activity types to be associated with MCr development.

The amount of time PA reported between 3-5 years did appear to have a positive effect on the child's creativity. However, it is unclear from this cross-sectional research whether the time in structured physical activities has given them the time to experience a wider variety of movements, or whether through participation in specific activities the child has developed both cognitively and physically to be more creative and imaginative with their movements? It is widely reported that participation in unstructured and structured play seems critical for motor and cognitive creativity development, carried out in a pleasant environment. As an environment that allows for playfulness, emotional safety, and active involvement of children and teachers is a basis for children to be physically creative (Isaksen et al., 2001; Trevlas et al., 2003; Vujičić et al., 2020). (Marinsek & Lukman 2021). In this study it is not clear which types of activities these were (i.e. gymnastics, dance, swimming etc…). Wang's (2003) intervention study found that a creative movement intervention did produce significantly greater performances whilst others found there to be a link between fitness and creativity showing that as the children improved coordination, flexibility etc. they improved their creativity (Roman, Vallejo & Aguayo's, 2018). Firth et al. (2019) systematic review summarised studies in this area only found weak to modest support for acute, moderate intensity exercise to benefit creativity, and that future research in this area required stronger methodological foundations.

In line with previous research into determinants of MCr of young children, the present study found no significant relationship between age and creativity as did Iscoe and Pierce-Jones (1964) scores of children aged five to nine years, measured using Guilford's

(1967) Unusual Uses Test. This is clearly an under researched area and this study is novel in its approach to look at MCr. Torrance and Forston (1960) observed that children seem to lose much of their creativeness about age five, possibly accounting for the lack of creativity we found at mean age of 6. This is in contrast to Zachopoulou et al. (2004), who noted age is an important factor for the development of MCr. Studies by Cleland (1990) and Cleland & Gallahue (1993) have also determined age as an important factor for the development of creativity. Dominguez, Diaz-Pereira & Martinez-Vidal (2015) found that MCr appears to increase between the ages of 6 and 12 years. Variances across the alternative studies in findings may be due to the different methodologies used to measure creativity, that are not always related to motor movements, and or the dissimilarity samples in age range most of the research in this area appears to be in children aged 10 years plus. Further research would benefit this area of study exploring the comparison of affect across age ranges and longer time scales to assess changes throughout the years. This study has only been able to capture a small sample of one age range and at the point that the literature suggests their fluency is lowering.

There were no associations with gender in the model of individual factors and MCr, consistent with previous research that reported that levels of creativity were similar in both sexes (Alsrour & Al-Ali, 2014; Cleland, 1990; Cleland & Gallahue, 1993; Johnson, 1977; Zachopoulou et al., 2004. Cheung et al., 2004; Park, 2007; Shi et al., 1999; Zachopoulou & Makri, 2005. Roman et al. 2017; Baer and Kaufman, 2008). Research that has examined the relationship between MCr and both, age and gender, are limited. Future research is required using longitudinal study designs to address the lack of literature about MCr. Little research has looked at the effect of MCr over time, unlike the large range of studies that have looked at the patterns in MP throughout childhood.

The present study did not find that participation in extracurricular activities was significantly associated with MCr. Although research seems to suggest that participation in extra-curricular activities is associated with improved creativity results in SES comparisons (Castillo-Vergara et al 2018). Castillo-Vergara et al (2018) found that female students who participated in extracurricular activities performed better in regard to creativity than their male counterparts. They recognised that to enhance student creative capacity, develop curiosity, initiative and creativity, participating in extracurricular school activities is recommended (Hui & Lau, 2006). The present study did not consider genders separately.

Social and Environmental Level

Considering the remaining layers of the socio-ecological model, neither the social nor environmental factors examined showed any significant associations with MCr. Limited research in this area is available to compare and contrast these findings. The literature supporting the importance of creativity at a young age and its contribution to overall MC development as well as PA participation warrants further research in this area.

*Summary of Socio-*ecological *Factors Affecting Motor Competency*

The evidence for the benefits of developing MC in the young child is ever growing, but the knowledge and understanding of how best to improve MC is lacking. Although some studies have aimed to identify associations of MC development in children it tends to be in relation to variables from either individual, social or environmental factors discreetly. This study has examined variables across all factors using the sociological model to collectively evaluate their association with young children MC. The results identified some correlates of MC in both MP and MCr across the layers of the socio-ecological model. In regression models, the only factors that showed any significance to a child's MC were at the induvial level of the model. Individual factors clearly have the biggest associations with a young child's MC, suggesting they are the most important factors that can influence their early motor development. This was however specific to MCr rather than MP. This raises the question of the importance of MCr development in young children to support their MC levels. The factors that appear to support this development is if the child is from a more affluent area geographical and the amount of time they spend in PA between the ages of 3-5 years. Data collected did not however make it clear what activities were most effective in this development nor did it identify a threshold of time for PA. Further work is needed to explore influences on MP and MCr.

This study has highlighted that the association between MC and its correlates is complex and differs according to proficiency and creativity. Just as Barnett et al. (2013) found whilst there is some evidence that motor skill in pre-school aged children is multidimensional, being associated with factors at the child, family and environmental level, though in the final regression models only factors at the child level were associated with motor skills. Further research is needed to clearly understand the impact of a child's individual factors on their MC development.

Strengths and Limitations

To the author's knowledge, this is the first study to explore socio-ecological correlates of both MP and MCr. The study used valid, reliable and age-appropriate measures of MP and MCr, and video analysis of skill performances ensured that the assessments could be scored with accuracy in a timely manner. In addition, this study contributes to the very limited area of literature in relation to MCr of young children and highlights the profile of MCr in a young child's MC development. It appears to be the first study to look at MP and MCr together in this context.

There were several limitations to the study. Firstly, only 28% (100 out of 360) eligible participants completed all the measures and were included in the final analysis, which may have influenced the findings. Second, the questionnaire data may be affected by recall bias and social desirability. Consequently, some effects might be undetected, and others might

be exaggerated. Therefore, results should be interpreted with caution (Cools et al. 2011). That said, there is some evidence that parents can reliably report psychosocial variables of their children (Dowda, 2007) and other child-led measures are less feasible due to the cognitive demands. Third, the cross-sectional design of the study may have restricted conclusions on effects because causality cannot be inferred from the data. Fourth, there was a lack of consideration given to some of the detail of activities e.g., the quality, intensity type and type of activity. Fifth, although all variables where categorised in one of the levels of the socio-ecological model it may be the some have an affect across levels and are not discrete strands. Some may be interlinked for example a child's ethnicity may influence their environment, a parents education impacts the amount of equipment they can provide. Finally, the motor competency data was analysed using combined scores. No consideration was given to examining the sub levels of locomotor, object control or stability motor outcomes in isolation. Likewise, for creativity the individual factors were not considered independently e.g. fluency, frequency. This may have lost some of the detail in the analysis.

Conclusion and Recommendations for Future Research

Although many previous studies have identified that a child is influenced by various socio-ecological factors, this study did not support that when considering individual, social and environmental influences on both MP and creativity. The only factors to show a significant association were at the individual level: deprivation, total time active between 3-5 (positive), total time active between 1-2.9 (negative), and this was only in relation to creativity. As suggested by McMinn et al. (2011) formulating an accurate understanding of specific parental and environmental factors influencing MC proficiency is a limited area of research but vitally important for the design and implementation of successful future interventions (McMinn et al*.,* 2011). Research has moved on slightly in this area but there is still much to be done to help develop a clear understanding of how to best to support young children's motor development.

If this study is accurate then it is the individual level that is most influential and therefore must be explored in more detail to allow parents, preschool providers and PA delivers to understand how best develop opportunities to counteract negative correlations that are out of control of their control e.g., social deprivation, gender, ethnicity etc. Future research in this area could look in more detail at the structure and quality of preschool activities. Is it time spent in specific activities i.e. gymnastics, swimming that helps as well as further considerations as are they delivered by qualified instructors, what is their purpose: participation or development etc. specifically for children aged 3-5 years.

The current Early Years and Foundation Stage Framework (EYFS) 2021 and National Curriculum for PE (NCPE) 2014, in England do require Early Years settings & schools to develop children's FMS to be competent and confident in a range of physical activities. They do not however mention anything specifically linked to motor creativity.

Creativity was previously mentioned in the 2007 NCPE when it was suggested that children in KS2 7-11 years should enjoy being physically active by using their imagination and creativity. If MCr is an important factor in helping develop young children's MC, as this study suggests, it is possible that young children in England are not receiving the opportunities to be able to develop their motor creativity and therefore their true potential motor competence.

The area of MCr is still a very much under researched area and this study has highlighted it is possibly something that is influenced more by pre-school PA experience than the child's MP. Further research to examine this relationship further again assessing specific physical activities, pedagogy and environments would be beneficial. As well as looking at more longitudinal impact on the child's creativity as it believed that this decreases with age and the contribution Mcr has on overall MC of a young child. A larger sample of would strengthen research in this area and benefit the probability of more reliable data; reduce anomalies and have less effect when averaged out over a larger number. The results are then more likely to be representative of the population.

This study is therefore in agreement with others in this field that there is still plenty of work to be done to be able to influence policy and address the lack of understanding and knowledge of promoting preschool and primary school motor skill development (Barela 2013, Clark, 2007; Lemos et al., 2012). MCr is possibly a neglected field of consideration when looking to develop MC in young children and could potentially be a missing link in the chain ~~of PA and~~ MC development.

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Appendices

Appendix 1.

Scoring for testing TGMD- performance criteria

Skill	Performance Criteria
Run	1. Arms move in opposition to legs with elbows bent 2. Brief period where both feet are off the surface 3. Narrow foot placement landing on heel or toes (not flat-footed) 4. Non-support leg bent about 90 degrees so foot is close to buttocks
Gallop	1. Arms flexed and swinging forward 2. A step forward with lead foot followed with the trailing foot landing beside or a little behind the lead foot (not in front of the lead foot) 3. Brief period where both feet come off the surface 4. Maintains a rhythmic pattern for four consecutive gallops
Hop	1. Non-hopping leg swings forward in pendular fashion to produce force 2. Foot of non-hopping leg remains behind hopping leg (does not cross in front of) 3. Arms flex and swing forward to produce force 4. Hops four consecutive times on the preferred foot before stopping
Skip	1. A step forward followed by a hop on the same foot 2. Arms are flexed and move in opposition to legs to produce force 3. Completes four continuous rhythmical alternating skips
Horizontal Jump	1. Prior to take off both knees are flexed, and arms are extended behind the back 2. Arms extend forcefully forward and upward reaching above the head 3. Both feet come off the floor together and land together 4. Both arms are forced downward during landing
Slide	1. Body is turned sideways so shoulders remain aligned with the line on the floor (score on preferred side only) 2. A step sideways with the lead foot followed by a slide with the trailing foot where both feet come off the surface briefly (score on preferred side only) 3. Four continuous slides to the preferred side 4. Four continuous slides to the non-preferred side
Two-Hand Strike	1. Child's preferred hand grips bat above non-preferred hand 2. Child's non-preferred hip/shoulder faces straight ahead 3. Hip and shoulder rotate and de-rotate during swing 4. Steps with non-preferred foot 5. Hits ball sending it straight ahead
One-Hand Strike	1. Child takes a backswing with the paddle when the ball is bounced. 2. Steps with non-preferred foot 3. Strikes the ball toward the wall 4. Paddle follows through toward non-preferred shoulder
Dribble	1. Contacts ball with one hand at about waist level 2. Pushes the ball with fingertips (not slapping at ball) 3. Maintains control of the ball for at least four consecutive bounces without moving the feet to retrieve the ball

Catch	1. Child's hands are positioned in front of the body with the elbows flexed 2. Arms extend reaching for the ball as it arrives 3. Ball is caught by hands only
Kick	1. Rapid, continuous approach to the ball 2. Child takes an elongated stride or leap just prior to ball contact 3. Non-kicking foot placed close to the ball 4. Kicks ball with instep or inside of preferred foot (not the toes)
Overhand Throw	1. Windup is initiated with a downward movement of hand and arm 2. Rotates hip and shoulder to a point where the non-throwing side faces the wall 3. Steps with the foot opposite the throwing hand toward the wall 4. Throwing hand follows through after the ball release, across the body toward the hip of the non-throwing side
Underhand Throw	1. Preferred hand swings down and back reaching behind the trunk 2. Steps forward with the foot opposite the throwing hand 3. Ball is tossed forward hitting the wall without a bounce 4. Hand follows through after ball release to at least chest level

Appendix 2. Table test of stability skills performance criteria

	Performance Criteria
Rock	1. Able to maintain and hold a seated tuck position (legs should be pulled in tight to chest) 2. Rock backwards onto nape of neck and shoulders keeping legs pulled into the body at all times. Rock back to seated position. 3. Rock back for a second time, keeping legs pulled into body (tuck shape). 4. During the second rock, when returning to the seated position, transfers weight to feet and drives up to standing position without placing hands on the floor at any stage
Log Roll	1. Rolls in a straight line across the mat, the child's path does not deviate to the left or the right. Child demonstrates four complete rotations. 2. Child's arms are extended above their head throughout the roll. Legs are extended throughout the roll with toes pointed. 3. Child demonstrates control throughout the roll. Arms and legs do not touch the ground
Back Support	1. Hands and arms positioned under shoulders. Arms should be straight and fingers pointing towards feet. 2. Legs straight and together with feet extended (heels should be the only part of the feet touching the floor). 3. The child exhibits good body tension by maintaining a straight diagonal line running from head to feet. 4. Back support is held for 30 seconds. 5. Back support is held for 45 seconds.

Appendix 3.

DMA -Pre-set DMA scoresheet

Ball task

Movements		*1*	*2*	*3*	*Etc.*
Sending	Overarm throw				
	Shoulder throw				
	Underarm throw				
	Sidearm throw				
	Over-the-head				
	Chest pass				
	Volley with arm				
	Volley with leg (no bounce)				
	Kick				
	Drop-kick (one bounce)				
	Header				
	Rolling				
	Drop				
	Bounce				
	Pushing along the floor				
Receiving object	Catch with one hand				
	Catch with two hands				
	Trapping				
Possession	Bounce & catch				
	Dribble hands				
	Dribble feet				
	Balance ball on body				
	Balance body on ball				
	Drop & catch				
	Passing ball around body				
Other					
Direction of ball at contact					
Direction of ball after contact					
Movement of person					
Equipment					
Relationships					
body					
other					
trial 1 fluency					
trial 2 fluency					
trial 1 flexibility					
trial 2 flexibility					

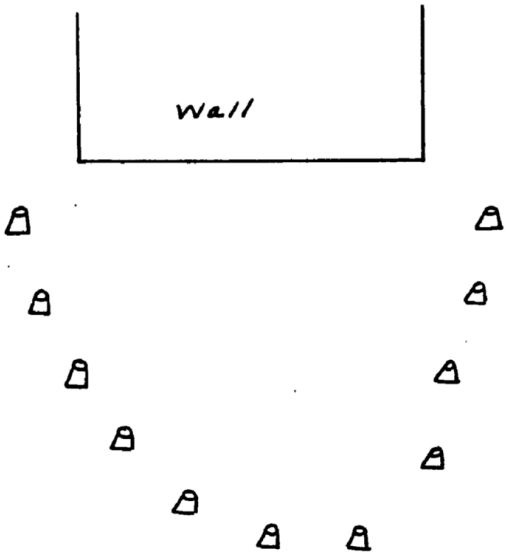
Locomotor task

		1	*2*	*3*	*Etc.*
Movements	Jump1-2ft				
	Jump 2-2ft				
	Jump 2-1ft				
	Jump & half-turn in air				
	Jump & full turn in air				
	Straddle Jump				
	Pike Jump				
	Star Jump				
	Tuck Jump				
	Pencil Jump				
	Frog Jump				
	Dive				
	Leap				
	Cartwheel				
	Round-off				
	log roll				
	Forward roll				
	Backward roll				
	Teddy bear roll				
	Rock				
	Commando crawl				
	Crawl (cat)				
	Crawl (bear)				
	Crawl (crab)				
	Step				
	Run				
	Walk				
	Hop				
	Gallop				
	Side-Gallop (side-step)				
	Slide				
	Skip				
	Hopscotch				
Direction	forward				
	other:				
Equipment					
Relationships					
body					
other					
trial 1 fluency					
trial 2 fluency					
trial 1 flexibility					
trial 2 flexibility					

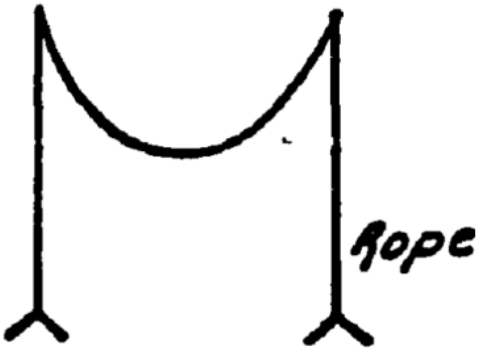
Stability task

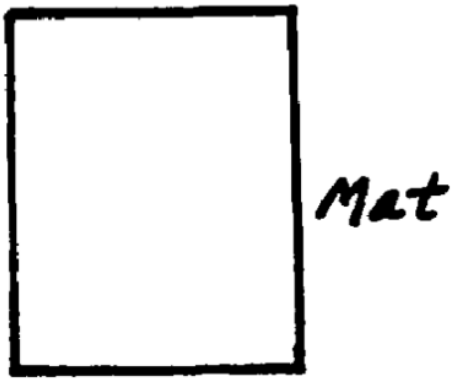
		1	*2*	*3*	*Etc.*
Movements	Arabesque				
	Arch				
	Back-support				
	Box splits				
	Bridge				
	Cat				
	Cobra				
	Crab				
	Dish				
	Donkey-kick				
	Downward dog				
	Handstand				
	Headstand				
	Kneeling				
	Lotus-position				
	Low plank				
	Lunge				
	Pike				
	Plank				
	Shoulder stand				
	Side lunge				
	Side plank				
	Splits				
	Squat				
	Standing split				
	Star				
	Straddle				
	Straight				
	Toe-touch				
	Tree-pose				
	Tuck				
	Reverse arabesque				
	V-sit				
	Y-sit				
	Y-stand				
	lying				
	Standing				
Right arm position					
Left arm position					
Right leg position					
Left leg position					
Relationship (objects)					
Other					
trial 1 fluency					
trial 2 fluency					
trial 1 flexibility					
trial 2 flexibility					

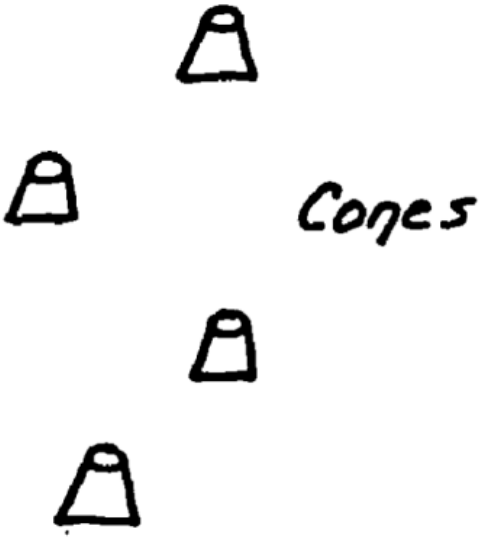
Appendix 4.
Diagram of the DMS tasks setting
Ball task



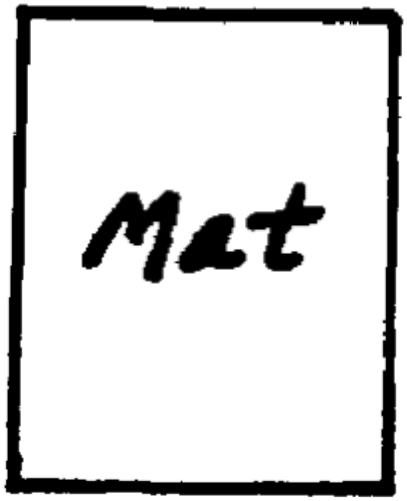
Locomotor task

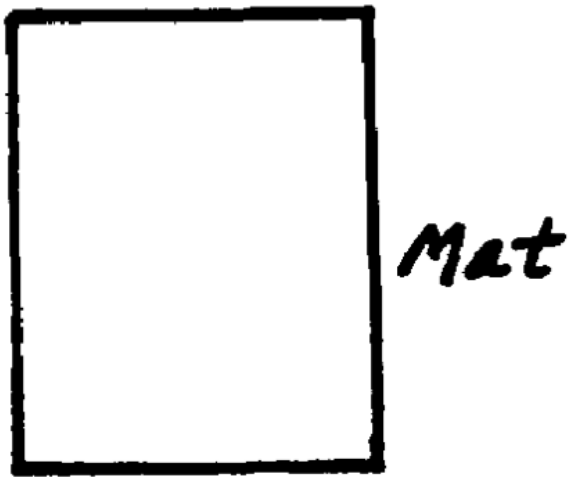


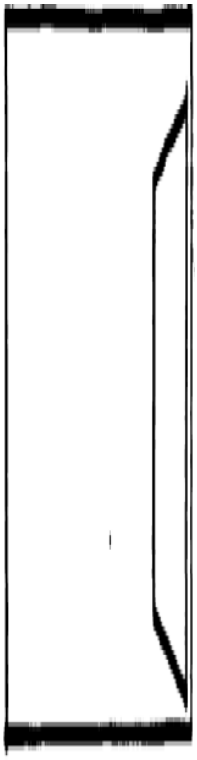




Stability task







Appendix 5. Description of DMA coding

Ball task

Coding starts with identifying movements the child is doing. Pre-set sheet has sending, receiving and possession. For example, if a child stands still and throw the ball towards the wall from the chest a 1 would be recorded in 'chest pass'. We then look down to towards the bottom of the sheet. Under direction of ball at contact, for the same 'chest pass' example we would type “still” (as it wasn't moving prior to the child throwing it). Under direction of ball after contact we would type “forwards” (as it was thrown forwards from the child). Under movement of person, we would type “still” as they child wasn't moving when they threw it. Relationships means the relationship between the ball and the equipment its intending to interact with so in this case we would write “towards” because the ball is going towards the wall. Body means what limb completed the skill so in this case it was “two hands”. Under other you would write anything of note so if the child did a little hop on left leg while they did it you may write that, anything to differentiate it from another chest pass they may do differently.

In conclusion for the yellowed areas, you would score 1s and leave blank if not present and you would type for the areas underneath it. It is very important to be consistent with the language used because when scoring trial two, it is still necessary to identify each different movement they do through the 90 seconds, even if the movements are the same as in trial one. Once two trials have been coded, to compare is easier to copy and paste trial two next to trial one (separated by a line) and colour code trial two. For example, looking across the two trials, if the child does a completely new skill in trial two (a different yellowed cell) then you fill that column with green (fluency), if they do a new variant of a skill they'd done before you colour it yellow (flexibility). This is why the language has to be consistent so it's easier to identify which movements were the same or different because the difference can be very subtle. At the very bottom of trial 1 of each station there's trial 1 fluency, trial 2 fluency, trial 1 flexibility, trial 2 flexibility. That's where their scores total up to get flexibility, fluency and total DMA score.

Locomotor task

Same system used as ball task, but now underneath the coloured in cells there are the “direction” which means the direction of movement the child is travelling; “equipment” is the equipment they interact with; “relationships” is what they're doing with that equipment: and “body” is the limb they led with (usually) or used. For example, a child is running you would score a 1 under run and you a 1 under forward. If for example, they were running backwards you would type “backwards” under other under direction instead of scoring a 1 under forward. If for example, they step into the hoop a 1 would be scored under step then a 1 under forward as that's the direction they're going, you would write “hoop” under equipment, type “into” under relationships as they're stepping into the hoop and write “right leg” as that's the leg they lead with.

Stability task

Again, same basic system as before (yellowed cells are fluency, writing underneath is to identify flexibility). For this task a rule was set that the child had to maintain a shape for about two seconds for it to count. A child can move very fluidly and looks like they're making shapes but if they don't hold anything in particular for a beat or two then it is not valid. So, in this task assessment the aim is to identify the closest shape you may think it resembles and then try to refine it using the limbs underneath. For example, if a child did the splits on the bench a 1 would be scored under splits, then you would write “right” under right arm, and “left” under left arm, under right leg would be “forward” and under left leg would write “backward”; for relationships you would type “on top” as they're on top of the bench.

Key things are:

1. Yellowed cells = fluency
2. Writing underneath yellowed cells = flexibility
3. Code each movement as they do it, even if they've done it before
4. Coding goes across column by column so the numbers at the top tell you how many movements they've done

Appendix 6.

SAMPLE-PE

Parent/Carer Questionnaire on physical activity and fundamental movement skills

This questionnaire should be completed by parents/carers. It asks for some background information about you, your physical activity and your child's activity. ***By completing and returning this questionnaire you are consenting to be part of this part of the research study and for this data to be used as described in the project information sheet provided in December. All data will be anonymised and your names will be removed"***

Please note: All the questions in this questionnaire relate to **your child** who is taking part in the SAMPLE-PE Research Project. Please complete the questionnaire in upper case / capital letters and return it to the school teacher within 14 days.

If you have any questions then email L.Foweather@ljmu.ac.uk or call 01512314152

code _____

Section A. Information about your child (participating in SAMPLE-PE)

1. Please write down today's date (dd/mm/yy): …… / …… / ……

2. What is your child's name? (please write in capital letters / upper case)

First name _____ Last Name _____

3. What is your child's date of birth? (dd/mm/yyyy) …… / …… / ……

4. What is their gender? (*please circle*) MALE FEMALE OTHER–please specify

5. What ethnic group do you consider the child belongs to? *(please tick one box)*

White

1. English / Welsh / Scottish / Northern Irish / British
2. Irish
3. Gypsy or Irish Traveller
4. Any other White background, please describe _____

Mixed / Multiple ethnic groups

5. White and Black Caribbean
6. White and Black African
7. White and Asian
8. Any other Mixed / Multiple ethnic background, please describe _____

Asian / Asian British

9. Indian
10. Pakistani
11. Bangladeshi
12. Chinese
13. Any other Asian background, please describe_____

Black / African / Caribbean / Black British

14. African
15. Caribbean
16. Any other Black / African / Caribbean background, please describe_____

Other ethnic group

17. Arab
18. Any other ethnic group, please describe_____

6. What is your child's home postcode? | | | | | | | |

7. In what country was this child born?

……..

8. What is the child's first language?

……..

9. What was the child's birth weight? (pounds or kg or 'don't know')

……..

10. Would you say your child is right or left handed? (please circle)

RIGHT-HANDED LEFT-HANDED BOTH NOT SURE

11. Would you say your child is right or left footed? (please circle)

RIGHT-FOOTED LEFT-FOOTED BOTH NOT SURE

12. How old was the child when they started at nursery?

YEARS …….. MONTHS

……

Section B. Information about your family household

1. How many adults live in the child's main family home (AGED 18 AND OVER)?

1 2 3 4 5 6 7 8 9 10

2. How many children live in the child's main family home?

1 2 3 4 5 6 7 8 9 10

3. Do the child's birth parents currently live together? YES NO

4. Please detail all the adults and children that live in your child's main household

Relationship to child participating in SAMPLE-PE (e.g. mother, father, brother, sister, grandmother, grandfather, step-mother/father/sister/brother, half-brother/sister, adopted, foster, etc.)	Age (years)	Ethnicity (see question 5 for response options)	Employment status (if aged over 18+): worker, employee, self-employed, full-time, part-time, unemployed, in education.

5. Does the child have any biological family members that are no longer living in this household?

Relationship to child participating in SAMPLE-PE (e.g. mother, father, brother, sister, etc.)	Age (years)	Ethnicity (see question 5 for response options)	Employment status (if aged over 18+) Examples worker, employee, self-employed, full-time, part-time.

6. What language is spoken in this child's household?

……

…….

7. What is the child's mother's highest educational qualification? (e.g. GSCE, A-Level, National Diploma, Higher National Diploma, NVQ3, NVQ4, NVQ5, Bachelor's Degree or equivalent, Masters Degree or equivalent, PhD, etc.)

……..

Section C. Your child's previous participation in sport and physical activity. To be completed by both Mum /Female Carer and Dad / Male Carer (if applicable)

8. What is the child's father's highest educational qualification? (e.g. GSCE, A-Level, National Diploma, Higher National Diploma, NVQ3, NVQ4, NVQ5, Bachelor's Degree or equivalent, Masters Degree or equivalent, PhD, etc.)

……..

1. What age did your child first join a sports club or dance club?

YEARS…… MONTHS……. or NEVER BEEN A MEMBER

2. Did your child take part in any sports or physical activities when they were a baby (aged 0-12 months). Examples might be baby yoga, gym tots or aqua babies

Name of activity / club	How many minutes long were the sessions?	How often were the sessions?	How many weeks/months did your child attend for?	How old was the child when they first started? (months/years)

3. Did your child take part in any sports or physical activities when they were a toddler (aged 1-3 years). Examples might be rugby tots, little kickers, etc.

Name of activity / club	How many minutes long were the sessions?	How often were the sessions?	How many weeks/months did your child attend for?	How old was the child when they started? (months/years)

4. Did your child take part in any sports or physical activities when during nursery / preschool years (aged 3-5 years; before they started formal school education)

Name of activity / club	How many minutes long were the sessions?	How often were the sessions?	How many weeks/months did your child attend for?	How old was the child when they started? (months/years)

Section D. Your child's current participation in sport and physical activity inside and outside of school

To be completed by both Mum /Female Carer and Dad / Male Carer

(if applicable)

1. Since being in Year 1 at school, has your child taken part in any organised sports clubs <u>at</u> school? (this means sports clubs that are organised by the school)

   o YES o NO

2. Please tick which organised school sports clubs your child has taken part in:

o My child has not played any sport or dance

o Football	o Basketball	o Dance
o Netball	o Volleyball	o Golf, putting, pitch & putt
o Hockey	o Baseball/softball	o Table tennis
o Cricket	o Dodgeball	o Ten pin bowling
o Rugby	o Tennis	o Swimming
o Rounders	o Badminton	o Cross-country
o Athletics	o Gymnastics	o Trampolining
o Climbing	o Cheerleading	o Martial arts (Judo, Karate, Taekwando)
o Cycling/Bmx	o Boxing	o Ice skating
o Rowing	o Canoeing	o Roller skating/blading or skateboarding
o Multi-skill	o Squash	o Horse riding / pony trekking

Other _____

3. Is your child currently a member of any organised sports or dance clubs outside of school? (this means formal sports clubs that are not organised by the school)

o Yes o No

4. Please tick which organised school sports clubs your child has taken part in:

o My child has not played any sport or dance

o Football	o Basketball	o Dance
o Netball	o Volleyball	o Golf, putting, pitch & putt
o Hockey	o Baseball/softball	o Table tennis
o Cricket	o Dodgeball	o Ten pin bowling
o Rugby	o Tennis	o Swimming
o Rounders	o Badminton	o Cross-country
o Athletics	o Gymnastics	o Trampolining
o Climbing	o Cheerleading	o Martial arts (Judo, Karate, Taekwando)
o Cycling/Bmx	o Boxing	o Ice skating
o Rowing	o Canoeing	o Roller skating/blading or skateboarding
o Multi-skill	o Squash	o Horse riding / pony trekking

Other _____

Section E. Your view on your child's physical activity

1. Compared with children from the same age and sex, how would you describe your child's levels of physical activity? (please circle)

Much less active		Average		Much more active
1	2	3	4	5

2. Compared with children from the same age and sex, I would say that my child is:

Much less skilful / coordinated		Average		Much more skilful / coordinated
1	2	3	4	5

3. How much does your child enjoy physical activity?

Physical activity Is not enjoyable		Average		Physical activity is very enjoyable
1	2	3	4	5

Answering questions 4 to 6

Please circle one answer per question, using the answer categories below.

1. strongly disagree 2. Disagree 3. neither disagree nor agree 4. agree

4.Would you describe your child as:	Strongly disagree				Strongly agree
a. physically active	1	2	3	4	5
b. restless	1	2	3	4	5
c. well-behaved	1	2	3	4	5
d. outgoing	1	2	3	4	5
e. sporty	1	2	3	4	5

5.Do you agree or disagree with the following statements about your child's activity?	Strongly disagree				Strongly agree
a. My child enjoys being physically active	1	2	3	4	5
b. My child enjoys ball games (e.g. catch, football)	1	2	3	4	5
c. My child enjoys movement games (e.g. tag, running)	1	2	3	4	5
d. I/we are concerned about the amount of TV my child watches	1	2	3	4	5
f. I/we think it is important that my child participates in physical activity and/or sports	1	2	3	4	5

6. I/We think it is difficult…	Strongly disagree				Strongly agree
g. …to encourage my child to go outside and play	1	2	3	4	5
h. …to encourage my child to play an active game instead of watching TV	1	2	3	4	5
i. …to play an active game with my child on a busy day	1	2	3	4	5
j. …to take my child outside to play when it is cold and wet outside	1	2	3	4	5
k. …to take my child outside to play when it is hot outside	1	2	3	4	5
l. …to play an active game with my child at the weekend	1	2	3	4	5
m. …to play an active game with my child when I am tired					

7. In general, would your child's own preference be to *(please tick one box per line)*:

play indoors	☐ OR	☐	play outdoors
play with toys	☐ OR	☐	watch TV
watch TV	☐ OR	☐	playing a running game with siblings or friends
play with balls	☐ OR	☐	Play with lego
Play on a tablet	☐ OR	☐	Going to the park
Do a puzzle	☐ OR	☐	Dance to some music

Answering questions 8 to 11

Please circle one answer per question, using the answer categories below.

1. never
2. rarely
3. sometimes
4. often

8. In general, how often do you…	Never				Very often
a. Encourage your child to do physical activities or play sports?	1	2	3	4	5
b. Do a physical activity or play sports with your child?	1	2	3	4	5

c. Provide transport so your child could go to a place where he/she can do physical activities or play sports? 1 2 3 4 5
d. Watch your child participate in physical activity or sport? 1 2 3 4 5
e. Tell your child that being physically active is good for his/her health? 1 2 3 4 5

9. In general, how often do you allow your child to do the following?

	Never				Very often
a. Watch TV at meal times	1	2	3	4	5
b. Go to bed when they want to	1	2	3	4	5
c. Play ball games in the house	1	2	3	4	5
d. Eat snacks while watching TV	1	2	3	4	5
e. Play in the park/ play area accompanied by older children (without adult supervision)	1	2	3	4	5
f. Run or ride a tricycle/scooter in the house	1	2	3	4	5
f. Play in the garden without adult supervision	1	2	3	4	5

10. In general, how often do you or your partner restrict the time your child spends doing the following activities?

	Never				Very often	*Not applicable*
a. Watching TV/video	1	2	3	4	5	*6*
b. Playing computer games (such as Xbox, PlayStation)	1	2	3	4	5	*6*
c. Playing outside	1	2	3	4	5	*6*
d. Using the computer / tablet	1	2	3	4	5	*6*

11. How often is **your child limited from doing an activity** because:

	Never				Very often
a. The fees for clubs or swimming pools are too high	1	2	3	4	5
b. It is difficult to get to physical activity places	1	2	3	4	5
c. My child doesn't have the skills to do the activity	1	2	3	4	5
d. My child is not interested in the activity	1	2	3	4	5
e. The weather is too bad	1	2	3	4	5
f. I am too busy	1	2	3	4	5
g. I am scared that my child will get hurt	1	2	3	4	5
h. There are no play areas/parks near our home	1	2	3	4	5

i. There are no other children to play with 1 2 3 4 5

j. There is no adult to supervise the child whilst playing 1 2 3 4 5

12. Not including when he/she is at school, on average, how many hours does **your child** spend playing outside (e.g. garden, park, etc.) during spring/summer and autumn/winter:

(Please put one tick (ü) on every line)

Hours of **outdoor play** per day	**Average time**					
	None	Less than 1 hour a day	1 to 2 hours a day	2 to 3 hours a day	3 to 4 hours a day	More than 4 hours a day
Autumn/Winter	n/a	n/a	n/a	n/a	n/a	n/a
On a week day						
On a weekend day						
Spring/Summer	n/a	n/a	n/a	n/a	n/a	n/a
On a week day						
On a weekend day						

13. Is there somewhere at home where your child can go out and play (e.g. garden)?

☐ Yes

☐ No (Go to question 16)

14. Does this outside space have (please tick one box):

☐ Little space for my child to run around and play

☐ Lots of space for my child to run around and play

15. Is this outside space (please tick one box):

☐ Suitable for ball games and sports activities

☐ Not suitable for ball games and sports activities

16. Does your child have the following equipment at home and how often does the child play with this equipment?

[1 = Never, 2 = Rarely (1-2 times month), 3 = Sometimes (3-4 times month), 4 = Often (1-2 times per week), 5 = Very Often (3+ times per week), 6 = n/a] Please circle

	Equipment	Never		Sometimes		V. Often
a. Baseball/Rounders bat	YES	1	2	3	4	5
b. Small balls (e.g. tennis balls, sponge balls)	YES	1	2	3	4	5
c. Football, rugby balls	YES	1	2	3	4	5
d. Basketball	YES	1	2	3	4	5
e. Bean bags	YES	1	2	3	4	5
f. Skipping rope	YES	1	2	3	4	5
g. Hula hoop	YES	1	2	3	4	5
h. Bicycle	YES	1	2	3	4	5
i. Trike/Tricycle	YES	1	2	3	4	5
j. Climbing frame/Slide/Swing	YES	1	2	3	4	5
k. Trampoline	YES	1	2	3	4	5
l. Scooter	YES	1	2	3	4	5
m. Sand pit / Water play area	YES	1	2	3	4	5
n. Nintendo Wii	YES	1	2	3	4	5

17. On average, how many hours does **your child** spend looking at screens at home (including watching TV / DVDs, tablet computer, smartphones):

(Please put one tick (ü) on every line)

Hours of **TV or tablet watched** per day	**Average over the last 4 weeks**					
	None	Less than 1 hour a day	1 to 2 hours a day	2 to 3 hours a day	3 to 4 hours a day	More than 4 hours a day
On a weekday						

On a weekend day						

18. How many Televisions are there in your household? .....

19. Does your child have any of the following in his/her home and in their bedroom?

(Please tick if yes, leave blank if no)

a. TV	☐ Home	☐ Bedroom
b. Video or DVD player	☐ Home	☐ Bedroom
c. Computer (e.g. PC/Laptop)	☐ Home	☐ Bedroom
d. Playstation or X-Box or Nintendo DS	☐ Home	☐ Bedroom
e. Nintendo Wii	☐ Home	☐ Bedroom
f. Arts and Crafts equipment	☐ Home	☐ Bedroom
g. Books	☐ Home	☐ Bedroom
h. Board games	☐ Home	☐ Bedroom
i. Tablet	☐ Home	
f. Mobile Phone (that is the child's)	☐ Home	

Section F. Mum / Female Carer Activities

To be completed by the Mum / Female carer (If n/a go to Section G.)

The questions below will ask **you** about the time **you** spent being physically active in the **last 7 days**. Please answer each question even if **you** do not consider yourself to be an active person. Please think about the activities you do at work,

within your household, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

No vigorous physical activities ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one
of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know / Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe
somewhat harder than normal. Think only about those physical activities that you did
for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like walking, carrying light loads, bicycling at a regular pace, or doubles tennis?

_____ **days per week**

No moderate physical activities ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one
of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know / Not sure

5. Are you currently a member of any sports or activity clubs? (please circle)

No Yes (please describe below)

Club or activity	How often do you play?	Does your child regularly come and watch you?

6. Have you ever played sport at a competitive level?

☐ I have participated in sport at a competitive level

☐ I have never participated in sport at a competitive level (Go to question 7)

7. This question is about your participation in sport during youth (0-18 years of age) and as an adult (18+). Have you ever participated in a sport at a.....?

(tick all that apply)

a. Amateur/Club level	☐ Youth	☐ Adult
b. County level	☐ Youth	☐ Adult
c. National level	☐ Youth	☐ Adult
d. European/World Championship level	☐ Youth	☐ Adult

8. How much do you enjoy participating in physical activity, sports and exercise?

Physical activity		Average		Physical
activity				
Is not enjoyable				is very
enjoyable				
1	2	3	4	5

Section G. Dad / Male Carer Activities

To be completed by the Dad / Male Carer (If n/a go to end)

The questions below will ask **you** about the time **you** spent being physically active in the **last 7 days**. Please answer each question even if **you** do not consider yourself to be an active person. Please think about the activities you do at work, within your household, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

No vigorous physical activities ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one
of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know / Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe
somewhat harder than normal. Think only about those physical activities that you did
for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like walking, carrying light loads, bicycling at a regular pace, or doubles tennis?

_____ **days per week**

No moderate physical activities ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one
of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know / Not sure

5. Are you currently a member of any sports or activity cluhs? (please circle)

No Yes (please describe below)

Club or activity	How often do you play?	Does your child regularly come and watch you?

6. Have you ever played sport at a competitive level?

☐ I have participated in sport at a competitive level

☐ I have never participated in sport at a competitive level
(Go to question 7)

7. This question is about your participation in sport during youth (0-18 years of age) and as an adult (18+). Have you ever participated in a sport at a.....?

(tick all that apply)

a. Amateur/Club level	☐ Youth	☐ Adult
b. County level	☐ Youth	☐ Adult
c. National level	☐ Youth	☐ Adult
d. European/World Championship level	☐ Youth	☐ Adult

8. How much do you enjoy participating in physical activity, sports and exercise?

Physical activity Is not enjoyable		Average		Physical activity is very enjoyable
1	2	3	4	5

Thank you for completing this questionnaire

Please return to the school teacher as soon as possible

within 14 days

Remarks about this questionnaire

Please give us your comments, such as any questions you thought were difficult to understand or where it was not clear how to answer the question.

Appendix 7.

Variable	Source	No. Items	Questions	Scoring system
Individual Level				
Demographic and biological variables		10	Dob, gender, Postcode Ethnicity, Country Child Born, Childs first language, Age start of nursery	
Behavioural variables PA In comparison with others Enjoyment levels Perceptions of PA	*New* *Southampton's Women Study* *Dowda et al 2011* *Dowda et al 2011* *McMinn*	4 2 1 3	PA participation 0-12 PA Participation 1-3 PA Participation 3-5 Sports clubs since year 1 in & out of school Compared with others PA levels Compared with others Co-ordination pa enjoyment levels my child enjoys pa my child enjoys ball games my child enjoys movement games	No of activities in and out of school Combined total 1=much less 5 =much more 1=much less 5 =much more 1=pa is not enjoyable 5= pa is very enjoyable /McMinn Agreement with: my child enjoys being physically active (strongly disagree to strongly agree). 1-5 Strongly disagree – strongly agree
Child personality	*McMinn et al 2009*	*5*	describe child as pa describe child as restless describe child as well behaved describe child as outgoing describe chills as sporty	Physically active; restless; well-behaved; inquisitive/outgoing (strongly disagree to strongly agree). Doesn't include sporty!
Activity Preferences	Mcminn et al 2009	6	Childs preference play inside outside Childs preference play toys watch tv	0=neg 1=pos (doesn't include ball/lego tablet/park puzzle/music)

			Childs preference watch tv play running game Childs preference play balls lego Childs preference play tablet park Childs preference play puzzle dance	
Mums education	*Cools et al 2010* *Trost 2003*	*1*	Level of education	Entry level = 0 Level 1 =1 Level 2 =2 Level 3 =3 Level 4 =4 Level 5 =5 Level 6 =6 Level 7 =7 Level 8
Dads education	*Cools et al 2010* *Trost 2003*	*1*	Level of education	Entry level = 0 Level 1 =1 Level 2 =2 Level 3 =3 Level 4 =4 Level 5 =5 Level 6 =6 Level 7 =7 Level 8
Social and cultural variables				
Family demographics				
Parents/adults	*McMinn 2000 &* *Cools et al. 2010*	*3*	No of adults at home No of parents? Parents live together (inc step parents)	Number 1- 5+ 0=<2 1=2 1=y 0=n
Siblings at home/not at home	*Bagley, Salmon & Crawford 2006*	*10*	No of children at home No of siblings at home No of younger siblings at home No of older siblings at home No of siblings not at home No of younger siblings not at home No of older siblings not at home Total No of siblings Total No of younger siblings Total No of older siblings	1-5+
Social Support	*Trost et al. 2003* *Dowda et al 2011 &*	*5*	how often encourage child to do pa sport how often do pa with child how often do you transport to pa/sport	1= Never 5= daily

	McMinn et al 2009		how often watch child participate pa/sport tell child pa/sport is good for health	
PA Rules	*McMinn et al 2009*	*4*	play ball games in the house play in park/play area accompanied by older children (without adult supervision) run or ride a tricycle/scooter in the house play in the garden without adult supervision	Scale 1-5
Barriers	*McMinn et al 2009*	*10*	how often child limited from activity because fees are too high how often child limited from activity because difficult to get too how often child limited from activity because don't have skills how often child limited from activity because child not interested how often child limited from activity because weather how often child limited from activity because busy how often child limited from activity because scared child gets hurt how often child limited from activity because no play areas near how often child limited from activity because no children to play how often child limited from activity because no adult	Scale 1-5 (Moore)
Parental PA Levels	*IPAQ*	*1*	Mothers PA levels	1-yes 0-no Numerical response if yes MET = minutes x MET x No days

				(Walking = 3.3, moderate =4, vigorous =8)
	IPAQ	*1*	Fathers PA levels	1-yes 0-no Numerical response if yes MET = minutes x MET x No days (Walking = 3.3, moderate =4, vigorous =8)
Enjoyment	*Trost et al. 2003*	*1*	Mothers PA enjoyment	*A five point Likert scale was used, with endpoints ranging from not enjoyable to very enjoyable*
	Trost et al. 2003	*1*	Fathers PA enjoyment	A five point Likert scale was used, with endpoints ranging from not enjoyable to very enjoyable
Physical environmental variables				
Time spent outside	*Salmon et al 2004*	*4*	average hours child plays outside autumn/winter weekday average hours child plays outside autumn/winter weekend average hours child plays outside spring/summer weekday average hours child plays outside spring/summer weekend	0- none 1- less than one hour 2- 1 to 2 hours 3- 2 to 3 hours a day 4- 3 to 4 hours a day 5- More than 4 hours a day
Home environment Space	Gabbard AHMED McMinn 2011	1	space at home to play	1-postitive 0-negative
	Salmon et al 2004	1	amount of space	1-postitive 0-negative Medium yard/large yard?
		1	outside space	1-postitive 0-negative
PA – equipment	*Salmon et al 2004*	*14*	child plays with baseball/rounders bat	1 present 0 not present

Availability Frequency of use	*(Although not as specific 6 categories)*		child plays with small balls child plays with football/rugby balls child plays with basketball child plays with beanbags child plays with skipping rope child plays with hula hoop child plays with bike child plays with trike child plays with climbing frame/swing/slide child plays with trampoline child plays with scooter child plays with sand/waterplay child plays with wii	Scale 1-6 never-often n/a coded 6 Combined in our questionnaire 0 – not present 1-5 how often used