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DEVELOPMENT AND VALIDITY OF THE MAT-PE

27 **Abstract**

28 **Introduction:** It is important to understand young children's motivation within Physical Education (PE)
29 so that researchers and teachers can effectively support children's physical, affective, social and
30 cognitive development as well as physical activity (PA) behaviors. However, there is a dearth of
31 motivation research in PE with children under the age of seven due to a lack of developmentally
32 appropriate assessment tools. **Aims:** This multi-study paper outlines the development content and
33 construct validity of a novel, mixed-method tool to assess young children's psychological needs and
34 behavioral regulation within PE (Motivation Assessment Tool for Physical Education; MAT-PE).
35 **Methods:** Study 1 consisted of the iterative development of the MAT-PE through working with 43
36 young children (ages 5-6) from three primary schools located within [REDACTED].
37 This work culminated in MAT-PE version 1, which was examined for content validity in a further sample
38 of 85 children (ages 5-6) from 12 primary schools located within [REDACTED].
39 Study 2 consisted of the development, content validation, acceptability and inter- and intra-rater
40 reliability of the MAT-PE codebook. Study 3 explored construct validity through hypothesis-testing via
41 correlational data. Descriptive data captured through the MAT-PE and codebook with 78 children
42 (ages 5-6) from 12 primary schools located within a large city in [REDACTED] is also presented.
43 **Findings:** The MAT-PE and its codebook were judged to have promising content validity, the codebook
44 was deemed acceptable, as well as demonstrating excellent inter- and intra-rater reliability (ICC = .90).
45 Regarding construct validity, as hypothesised, all psychological needs were positively correlated and
46 autonomous regulations were negatively associated with amotivation. There were also unexpected
47 correlations such as the negative correlation between intrinsic and identified regulation. **Conclusion:**
48 Further development of the MAT-PE is required; however, this study has taken a promising first step
49 in developing a tool to comprehensively measure five- to six-year-old children's motivational
50 perceptions in PE.

51 **Keywords:** self-determination theory; physical education; children; mixed methods;
52 codebook, assessment

53 Introduction

54 Physical Education (PE) supports physical, affective, social and cognitive development for
55 primary school aged children (5-11-years-old) and promotes healthy lifestyles (Bailey, 2006; Casey &
56 Goodyear, 2015; Hills et al., 2015; Loprinzi et al., 2015; Marques et al., 2017; Sallis et al., 1991, 2012;
57 Tsangaridou & Lefteratos, 2013). Focusing on the affective domain, PE provides a context to foster
58 children's perceived competence, motivation and enjoyment in physical activity (PA) and movement
59 (Carroll & Loumidis, 2001; Chen, 2014). Early learning experiences in PE are thus considered critical
60 for continued participation in PA (Hills et al., 2015; Kirk, 2005), with enjoyment of PE positively
61 affecting future attitudes and intention towards PA (Ladwig et al., 2018). Motivation is a mechanism
62 that helps sustain behaviour and engagement within PE. Therefore, understanding how to foster and
63 maintain motivation in children within primary PE is key for supporting their PA participation (Jaakkola
64 et al., 2013; Standage et al., 2003), physical literacy and well-being (Whitehead, 2019).

65 Guay et al. (2010) demonstrated that children aged six to ten years report on their motivation
66 differently between school subjects, highlighting the importance of assessing children's motivation
67 according to specific subjects. Despite variances in cognitive ability and communication skills, young
68 children (aged 4-7 years) are able to recognise the subject of PE as a forum for learning how to move
69 their bodies, to exercise and get fit, and can recall activities completed during PE lessons (Solmon &
70 Carter, 1995). As such, the present paper is concerned with young children's contextual motivation
71 toward PE (Vallerand, 1997, 2007). Specifically, we were interested in young children's ability to
72 conceptualise a) the motivating factors driving their PE behaviours, and b) the social-contextual
73 factors within the PE environment that relate to the satisfaction of autonomy, competence and
74 relatedness. These conceptualisations are the central tenets of Organismic Integration Theory (OIT)
75 and Basic Psychological Needs Theory (BPNT) respectively, which of the six mini-theories within Self-
76 Determination Theory (SDT; Ryan & Deci, 2017), are arguably the most widely used in PA (Teixeira et
77 al., 2012) and PE research (Vasconcellos et al., 2019).

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78 OIT focuses upon internalisation and integration, resulting in different types of motivation
79 that vary in their degree of autonomy as well as in their specific antecedents and effects on experience
80 and behaviour within a socio-cultural environment such as PE. OIT is centred around the tenet that
81 some behavioral regulations are experienced as “relatively alien to the self” while others are more
82 “autonomously enforced” (Ryan & Patrick 2009, p. 112), whereby extrinsic motivation lies upon a
83 continuum of autonomy. After amotivation (no motivation to act) are two forms of controlled
84 motivation characterised by pressured engagement in an activity: external regulation (driven by
85 reward or avoidance of punishment and considered the least internalised form of motivation), and
86 introjected regulation (driven by the ego/pride or guilt/shame). Following with increasing degrees of
87 internalisation are identified regulation (driven by a desire to pursue an internal goal) and integrated
88 regulation (driven by aligned values and behaviours). Together with intrinsic regulation (driven by
89 inherent pleasure, interest or challenge), identified and integrated regulation are forms of
90 autonomous motivation, characterised by levels of volition and self-endorsement (Ryan & Deci, 2017).

91 For children to flourish in wellbeing and performance, three basic psychological needs (BPN)
92 must be supported and satisfied within the social environment, leading to autonomous motivation
93 (Katz et al., 2011; Milyavskaya & Koestner, 2011; Standage et al., 2012). The needs are *competence*
94 (the need for satisfaction in demonstrating capabilities), *autonomy* (the need for actions to be
95 volitional and a sense of choicefulness (Vansteenkiste et al., 2005)) and *relatedness* (the need to seek
96 out connected relationships with others: Deci & Ryan, 2000). Past research in older children have
97 shown that children perceive higher levels of relatedness and more moderate levels of autonomy
98 (Ntoumanis et al., 2009; van Aart et al., 2017), while it is common to find higher competence levels in
99 younger (Barnett et al., 2015; Spessato et al., 2013). Thus, the extent of internalisation (and the quality
100 of motivation) and need satisfaction experienced by a child in PE is dependent upon the extent to
101 which the three BPN are supported by their PE teacher’s delivery style and the PE environment.
102 Autonomy can be supported by providing meaningful choices, competence by providing guidance, and
103 relatedness by providing a friendly demeanour (Ryan & Deci, 2017). Thus, autonomy, competence and

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104 relatedness act as mediators between the contextual factors (PE teacher and children's peers) and
105 contextual motivation (intrinsic, extrinsic and amotivation) (Vallerand, 1997, 2007).

106 Across the globe, research supports the use of SDT as a framework for supporting positive
107 experiences and participation in PE. In the USA, Erwin et al. (2013) found that autonomy support
108 (choice vs no choice) and lesson structure (individual vs group activities) affected PA levels during PE
109 among 8-11-year-olds. Leptokaridou et al. (2016) found positive relationships between autonomy-
110 supportive teaching and effort and enjoyment in PE among 10-12-year-olds from Greece, while
111 Escriva-Boulley et al. (2018) reported a positive association between autonomy support and
112 moderate-to-vigorous physical activity (MVPA) during PE in 5-11-year-olds from France. Within the
113 UK, numerous studies have explored SDT in PE among youth (aged 11 to 16 years: Ntoumanis, 2005;
114 Standage et al., 2003, 2005; Taylor & Ntoumanis, 2007). These studies also demonstrate that a need
115 supportive motivating teaching style in PE leads to greater need satisfaction among students, which
116 in turn predicts intrinsic motivation and future participation in PA inside (optional PE) and outside of
117 school (leisure PA). However, to our knowledge, no study has explored young children's (5-7-year-
118 olds) motivation for early primary school PE. This age period is important to understand,
119 motivationally, as MVPA levels begin to decline from the age of school entry (Reilly, 2016).
120 Furthermore, while previous literature in 8- to 12-year-olds has reported that motivation for PE,
121 assessed using a 33 item Likert scale survey, declines with age (Chanal et al., 2019), it is important to
122 understand whether this decrease occurs at an earlier age to put in place preventative actions. Given
123 that children can differentiate between behavioral regulations far earlier than first posited (Butler,
124 2005), examining 5-7-year-olds motivation for PE warrants further study in order to investigate how
125 different learning environments, motivational climates and PE teaching styles affect self-determined
126 motivation through their impact on perceptions of competence, autonomy, and relatedness.

127 One of the reasons for a lack of research into young children's motivation is the paucity of
128 measurement tools available for this younger age group (Sebire et al., 2013). Indeed, few tools exist
129 specifically for use with young children. For instance, Gottfried (1990) adapted The Children's

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130 Academic Intrinsic Motivation Inventory (CAIMI; Gottfried, 1986) for use in younger children (ages 7-
131 9; Gottfried, 1990). In another example, Guay et al. (2010) modified the Academic Motivation Scale
132 (AMS; Vallerand et al., 1989) to create the Elementary School Motivation Scale (ESSMS) designed for
133 use in 6-9-year-old children. However, it should be noted that these quantitative tools focused
134 exclusively on intrinsic motivation (Gottfried, 1986, 1990), collapsed motivational constructs (Guay et
135 al., 2010), omitted amotivation and were not PE specific. By isolating single components and grouping
136 constructs into broader categories, these measures are insensitive to motivational intricacies and fail
137 to provide a comprehensive assessment of young children's motivation. Furthermore, these surveys
138 typically capture responses using Likert scales (except for the ESSMS which used a double-binary
139 response system), which have been found to be unreliable among young children due to their limited
140 cognitive understanding (Mellor & Moore, 2014). Gelman and Baillargeon (1983) argued that young
141 children think dichotomously; thus, future research should incorporate alternative response formats
142 into assessments (Mellor & Moore, 2014). Research exploring young children's perceived competence
143 has demonstrated success in using structured alternative response formats and utilising pictures
144 within their measurement tools (Harter & Pike, 1984; Barnett et al., 2015). Such research instruments
145 could inform the design of assessments of motivation for PE within this age group.

146 Children as young as five years of age have been found to be able to describe their internal
147 mental states such as their perceptions, emotions, cognitions and physiological states (Stone &
148 Lemanek, 1990). This suggests that qualitative methodologies could be used to elicit young children's
149 voices concerning 'why questions' for motivation in PE. Previous research (Chandler & Connell, 1987)
150 has used a structured interview procedure and content analysis to explore behavioral regulations
151 towards general 'liked' (e.g., playing a board game) and 'disliked' (e.g., going to bed on time)
152 behaviours amongst children aged 5-13-years-old. Importantly, this research showed that intrinsic,
153 extrinsic and internalised forms of motivation are conceptually and developmentally distinct, and
154 therefore should be explored separately within children's motivational research (not collapsed or
155 omitted). However, while the methodology shows some promise, the study did not examine PE,

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156 amotivation was not considered, and the types of behavioral regulation were not clearly delineated.
157 Other research has examined motivation for reading in 6-8-year-old children through qualitative case
158 studies (Erickson, 2019), however, again, the study did not examine PE and the sample size was small
159 due to the methodology (n=8). Qualitative methods published in other fields of research could offer
160 promising approaches to assessing young children's motivation. For example, the Write and Draw
161 technique alongside semi-structured interviews has been effectively used to capture views on passive
162 smoking in children aged four to eight (Porcellato et al., 2005; Woods et al., 2005). Evolving this
163 methodology, Noonan et al. (2016) developed a humanistic, child-led interactive method called the
164 Write, Draw, Show and Tell which successfully gathered 10 to 11- year-old children's perspectives on
165 PA and may offer a viable means by which to explore BPN and behavioral regulation in younger
166 children. Developing a tool that can assess young children's motivation within PE would benefit
167 researchers as it would improve understanding of the psychological mediators that affect young
168 children's motivation and related contextual cognitive, affective and behavioral outcomes (Ferrer-Caja
169 & Weiss, 2000) and as such inform intervention design. Furthermore, educational curricula aim to be
170 more child-centred (Department of Education, 2014) but no appropriate tools for affective outcomes
171 exist. A novel tool is therefore needed to better understand young children's motivation within PE
172 which could inform teaching styles, bridging the gap between research and practice.

173 In summary, supporting children's motivation within PE is crucial for their holistic
174 development (Bailey, 2006; Casey & Goodyear, 2015). Little is known about young children's (five- to
175 six-year-old) motivation towards PE due to a lack of empirical studies (Vasconcelloset al., 2019), which
176 is likely due to a lack of developmentally-appropriate measures (Sebire et al, 2013). To date,
177 quantitative and qualitative methods have been utilised separately in order to measure motivation,
178 primarily within OIT, in academic subjects, and with older children. A mixed-method approach would
179 provide a more comprehensive overview of motivation in PE among young children (Caruth, 2013).
180 Therefore, we aimed to develop an age-appropriate, mixed-method tool aligned with SDT in order to

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181 measure young children's motivation in PE (Motivation Assessment Tool for Physical Education; MAT-
182 PE).

183 This paper reports the initial development and content validity of the MAT-PE and its
184 associated codebook. According to the Consensus-based Standards for the Selection of Health
185 Instruments (COSMIN: Mokkink et al., 2010; Terwee et al., 2018), content validity, defined as 'the
186 degree to which the content of an instrument is an adequate reflection of the construct to be
187 measured' (Mokkink et al., 2010), is the most important measurement property of a tool and the key
188 focus for tool development (Terwee et al., 2018). We also present preliminary descriptives to illustrate
189 the MAT-PE data and an initial exploration of construct (structural) validity, another important
190 measurement property for evaluating outcome measures (Prinsen et al., 2016). COSMIN guidelines
191 state the need for *a priori* hypotheses for construct validity (Mokkink et al., 2012). Thus, based on SDT
192 research (Ryan & Deci, 2017; Sebire et al., 2013; van Aert et al., 2017), broadly we hypothesised and
193 expected that 1) BPN will positively associate with each other, 2) BPN will positively associate with
194 autonomous regulations and negatively associate with controlled regulations and amotivation, 3)
195 introjection will demonstrate complex associations with the other variables, and 4) behavioral
196 regulations will ascribe to the simplex model (Ryan & Connell, 1989). This research is reported across
197 three studies (Table 1). All studies took place within a wider cluster randomized controlled trial (RCT;
198 Rudd et al., 2020) and were approved by the university research ethics committee (Ref. 17/SPS/031).

Table 1

Indicative content of the studies presented in this manuscript

Study 1 <i>Development & content validity</i>	Study 2 <i>Analysis and scoring</i>	Study 3 <i>Construct validity</i>
<ul style="list-style-type: none"> • Development of the MAT-PE 	<ul style="list-style-type: none"> • MAT-PE Codebook development 	<ul style="list-style-type: none"> • MAT-PE descriptive data
<ul style="list-style-type: none"> • Description of the MAT-PE 	<ul style="list-style-type: none"> • Content validity and acceptability of the MAT-PE codebook 	<ul style="list-style-type: none"> • Hypothesis-testing (correlations)
<ul style="list-style-type: none"> • Content validity of the MAT-PE 	<ul style="list-style-type: none"> • Reliability of the MAT-PE codebook 	

Note. MAT-PE=Motivation Assessment Tool for Physical Education

200 Study 1: Development and content validity of the MAT-PE**201 Method****202 Tool development**

203 Supplementary Material A provides a detailed overview of the iterative development of the
204 MAT-PE tool and resources. Briefly, methodological development was guided COSMIN, more
205 specifically, COSMIN guidelines on content validity, which is a methodology developed via Delphi study
206 including 159 experts from 21 countries in order to produce guidelines on content validity (COSMIN;
207 Terwee et al., 2018). In accordance with this guidance and that of Dunn et al. (1999), a team of cross-
208 disciplinary researchers (KFD, PW, JR, SR, FB, ZK, LF) constituted of Professors, Readers and Senior
209 Lecturers with primary areas of expertise focused around qualitative methods, tool development,
210 psychological well-being in children, health behaviour change in children, PE, PA and motor learning
211 and development took part in a series of interactive meetings to co-produce the motivation tool. All
212 members of the research team had at least 15 years of experience working or researching with
213 children (maximum of 30 years). All but one had published within the SDT area, with half having
214 published at least four SDT-related journal articles. Guidelines from COSMIN also state that the target
215 population should be involved with the development of tools that measure an outcome within its
216 population (Wiering et al., 2017). Therefore, development, testing and redesigning of the MAT-PE
217 involved members of the research team working with a convenience sample of 43 children aged 5-6
218 years old (54% male) from three primary schools over three weeks (Supplementary Material B). This
219 process resulted in the final version of the MAT-PE that was deemed by the research team, through
220 their respective relevant expertise, to be feasible and show promise of content validity that warranted
221 further study. The MAT-PE tool and content validity testing are described in the following sections.

222 Description of the MAT-PE

223 The MAT-PE was developed as a pragmatic, mixed-method tool to overcome the challenges
224 of conducting research with young children (Evans & Fuller, 1996, 1998) and to enable richer insights
225 to be captured surrounding children's interpretations of their experiences (Caruth, 2013; Ponce &

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226 Pagán-Maldonado, 2015). The tool aims to assess *what* (quantitative) children's motivational
227 perceptions are within PE and *why* (qualitative) they have those particular perceptions. The reasons
228 for mixing the quantitative and qualitative strands within the tool was to *answer different research*
229 *questions* (what and why), provide an *explanation* (qualitative to explain quantitative findings) and
230 *illustrate* (qualitative putting 'meat on the bones' of quantitative findings) children's motivations
231 within PE (Bryman, 2006). These aspects are depicted in Supplementary Material C.

232 Table 2 describes the MAT-PE tool. The MAT-PE comprises a classroom draw and write activity
233 followed by a semi-structured interview that is administered in a one-to-one format by a trained
234 researcher. The semi-structured interview utilises a pictorial instrument and consists of interactive
235 activities (e.g., choosing, sorting) designed to capture motivational perceptions within SDT-related
236 constructs: enjoyment, relatedness, autonomy, competence and self-determined motivation. The use
237 of visual resources was designed to overcome issues with children's attention span, verbal ability and
238 abstract thinking. For each activity, the child is presented with the associated picture cards and
239 receives a scripted set of explanations and questions from the interviewer that are compiled in the
240 instruction manual. Children are directed to choose the card(s) that best represents their thinking
241 (fixed choice: quantitative strand, the what) and then the interviewer asks a series of open-ended
242 questions with probing to understand their fixed choice selection (qualitative strand, the why).

243 Enjoyment can be considered as an aspect of intrinsic motivation (Deci & Ryan, 1991);
244 however, enjoyment can be seen as a standalone construct (Kimiecik & Harris, 1996), and has related
245 positively to actual PA, PA intention, and high levels of motivation (Best et al., 2017; Bungum et al.,
246 2000; Yli-Piipari et al., 2009). The draw and write technique was used to assess children's enjoyment
247 of PE and was conducted as a classroom-based activity. This activity was informed by the Write, Draw,
248 Show and Tell procedure by Porcellato et al. (2005) and Noonan et al. (2016). Children were asked to
249 draw a picture of 'what they like about PE' on one side of an A4 blank paper and 'what they don't like
250 about PE' on the other side.

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Table 2

<i>Description of the MAT-PE</i>		
Construct	Activity description	MAT-PE resources
Whole-class activity		
Enjoyment part 1: Draw and Write	Children were given 30 minutes to draw pictures of what they liked and/or disliked about PE.	
Activities completed one to one with researcher		
Icebreaker: Pair-matching card game	A set of PE-themed cards were laid face-up before the child. The child is asked to remember where all the matching pictures are so when turned over, they turn over only the matching pictures.	
Enjoyment part 2: Discussion around like/dislike of PE drawings	<p>Children presented with their drawings about what they liked and/or disliked about PE.</p> <p>Quantitative: <i>I asked you to draw a picture of what you like about PE, what have you drawn here?</i></p> <p>Qualitative: <i>Why do you like...?</i></p> <p><i>I asked you to draw a picture of what you don't like about PE, what you have drawn here?</i></p> <p><i>Why don't you like...?</i></p> <p><i>You haven't drawn anything, why is that?</i></p> <p>This is considered quantitative as children either drew/wrote what they liked or disliked, or they did not.</p>	Draw and write pictures from Part 1

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Relatedness: Children presented with two sets of two cards: one set focused on the PE teacher relationship and one set on peer relationships.
 Choose and discuss

Quantitative: *This girl/boy's PE teacher likes them very much, this girl/boy's PE teacher doesn't like them very much, which girl/boy are you most like?*
 Qualitative: *How do you know your PE teacher likes/doesn't like you? What do they say or do that makes you think that they like/don't like you?*

Do you like your PE teacher?

Why do you/don't you like your PE teacher?

Other children let this girl/boy play with them in PE, other children don't let this girl/boy play with them in PE, which girl/boy are you most like?

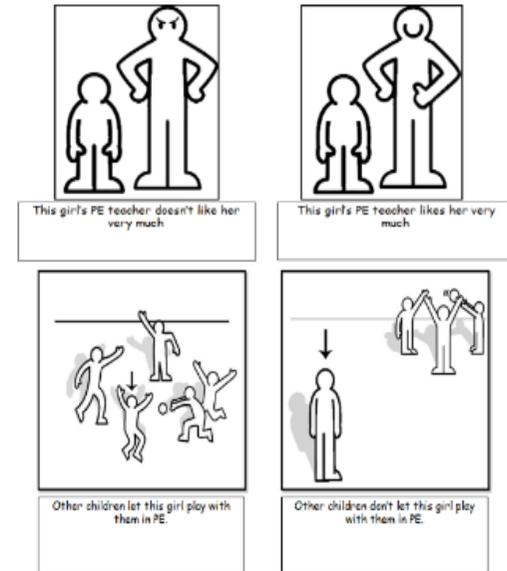
Can you tell me about a time when other children let you/didn't let you play with them in PE?

Do you let other children play with you in PE?

Is it important to let them play? Why? Why not?

Autonomy:
 Sorting

The child was presented with two plates: labelled "You" (the child's plate) and labelled "PE teacher" (the PE teacher's plate). Each child is shown a series of PE equipment they might be able to choose in PE and asked to sort them into whether they think they get to choose or the PE teacher chooses for them.



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Quantitative: *There are some things in PE that you might get to choose and there are some things in PE that your PE might choose for you, which things do you get to choose?* Qualitative: *Can you tell me about a time you got to choose that?*

Do you ever get to choose the activities in PE or does the PE teacher?

Do you get to choose how you do movements and actions in PE or does the PE teacher show you and tell you how to do them?

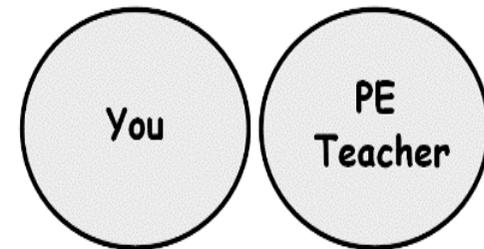
If you have a question for your PE teacher, do they answer it?

If you have something to say to your PE teacher, do they listen to you?

Competence:
Choose and discuss

The child was presented with a series of fundamental movement skills and 1 to 5-star star-chart and were told: A child who can do all of these things all of the time would get five stars. A child who can do most of these things most of the time would get four stars. A child who can do some of these things some of the time would get three stars. A child who can a couple of things would get two stars. A child who can maybe one thing would get one star.

Quantitative: *How many stars would you give yourself for doing things in PE?* Qualitative: *Why would you give yourself...star(s)?*



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Self-regulation: Choose, sort and discuss
 The child was presented with all the reasons why they might take part in PE: I do PE because PE is fun (intrinsic), I do PE because I want to be healthy and strong (identified), I do PE because I want my teacher and classmates to like me (introjected), I do PE because I might get a reward (external approach), I do PE because I don't want to get into trouble (external avoid), I don't want to do PE (amotivation). They were asked to choose their favourite reasons for taking part. They were then asked follow-up questions for each chosen reason. They were then asked to place the chosen reasons in order of importance for them.

Quantitative: *Out of all these reasons, which are your favourite reasons for doing PE?*

Can you place your reasons into order of importance where the first means the most important?

Qualitative:

Intrinsic: *Why is PE fun?*

Identified: *Why is being healthy and strong important to you?*

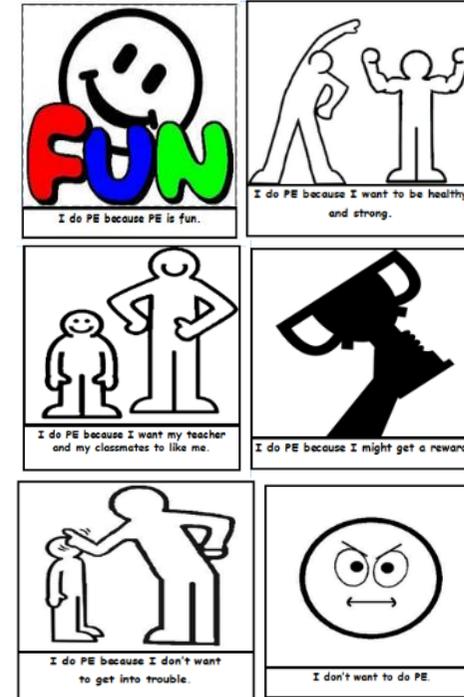
Introjected: *Why is it important that your teacher and classmates like you?*

Do you ever feel like you need to do PE to show other children and teacher how good you are at PE?

External (reward): *Do you get rewards in PE? What rewards do you get in PE?*

External (punishment): *If you knew you wouldn't get into trouble, would you still want to do PE? Why?*

Amotivation: *Why don't you want to do PE?*



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255 Following completion of the draw and write activity, a trained researcher escorted the child
256 to an adjacent location away from the classroom for the completion of the one-to-one interview. The
257 interview commenced with a PE-themed pair-matching card game to build rapport between the child
258 and researcher (Irwin & Johnson, 2005). Each child was then presented with their drawing from the
259 classroom-based activity and a discussion occurred between the researcher and child about their
260 pictures (Noonan et al., 2016; Porcellato et al., 2005).

261 The MAT-PE pictorial instrument and interactive activities were subsequently utilised in the
262 interview with the child to assess each SDT construct (relatedness, autonomy, competence need
263 satisfaction and behavioral regulation). For relatedness, questions addressed both PE teachers and
264 peers as it has been found that both social agents effect children’s relatedness (Vasconellos et al.
265 2019). A structured alternative response format (Barnett et al. 2015; Harter & Pike, 1984) was used
266 (see Table 2); once the child chose which child they are most like their choice was discussed with them.

267 The autonomy activity focused upon the choicefulness element of autonomy, more
268 specifically procedural (e.g., choice of equipment), organisational (e.g., peer selection) and cognitive
269 (e.g., choice of activities; Stefanou et al. 2004). For example, children were shown a selection of PE
270 equipment and two plates labelled “you” for the child and “PE teacher” for their PE teacher. The
271 children were asked to sort the PE equipment onto their plate if they ever got to choose it in PE or
272 sort onto their PE teacher’s plate if the PE teacher chose it. Children were then asked to expand.
273 Additionally, children were asked if they got to choose the movements or activities that they did in PE
274 and if they felt that their PE teachers listened to them and answered their questions. This item centred
275 on opportunities for input, which is considered as an autonomy characteristic (Ryan & Deci, 2017).

276 Within the competence activity, children were asked to rate themselves on a 1-5-star star-
277 chart (“How good are you at things in PE?”) based on pictures of fundamental movement skills which
278 the development of is a main outcome for PE (Department of Education, 2013; UNESCO, 2013).

279 Within the behavioral regulation activity, each child was presented with six picture cards each
280 representing a source of behavioral regulation (see Table 2). The pictures included a written stem that

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281 was informed by previous literature (Guay et al. 2010; Sebire et al. 2013). Integration was omitted as
282 it is thought that this type of regulation does not emerge until adolescence or adulthood (Ryan & Deci,
283 2017). External regulation was split into approach (reward) and avoidance (punishment). Each type of
284 regulation was presented to the children, one at a time, and read aloud. Children were asked to choose
285 their most favourite reasons for taking part. For any choice they make they were then asked a related
286 follow-up question for that type of regulation. They were then asked to put the chosen regulations
287 into order of importance from most important to least important where more than one type of
288 regulation can be positioned the same, e.g., intrinsic and external reward as first, external punishment
289 as second and identified as third. Once completed, the researcher thanked the participant, gave them
290 a sticker and escorted them back to the classroom.

291 Interviews were recorded using a Dictaphone; children wore microphone clips to aid recording
292 quality. Conversations were typed up verbatim in the form of an interview transcript (qualitative) and
293 fixed choice item selections were recorded (quantitative) for subsequent analysis (see Study 2). The
294 total time for administration was approximately one hour, inclusive 30 minutes for the write and draw
295 enjoyment activity and approximately 25 minutes for the SDT MAT-PE activities.

296 Content validity of the MAT-PE

297 Content validity testing of the MAT-PE was undertaken by the research team in a sample of
298 children during baseline assessments of the cluster RCT examining PE in primary school-aged children
299 (Rudd et al., 2020). Following recommendations from Dunn et al. (1999), content validity was also
300 examined among researchers with expertise in SDT who were independent of the tool development.

301 Methods**302 Participants****303 Children**

304 Informed written head teacher and parent/guardian consent and child assent were obtained
305 for n=360 children from 18 Year 1 classes (5-6 years) within 12 primary schools located within a large
306 city in North West England to participate in the cluster-RCT. A random sub-sample of eighty-five

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307 children (aged 5-6, 47% male) - approximately 5 children per class - were selected from a pool of
308 research participants to undertake MAT-PE. These children were deemed by the class teacher to be
309 able to speak and listen in English to an adult visitor to the school (i.e., visiting researcher).

310 Independent researchers

311 Fifteen researchers who worked within the area of SDT were contacted via email through
312 snowball sampling; nine researchers agreed to participate in the study. This sample constituted of
313 professors, assistant professors and lecturers in health psychology, sport and exercise psychology, and
314 sport and movement education. Primary areas of expertise included health psychology, motor
315 development, motivation and behaviour, exercise motivation, PE, STD, and behaviour change. This
316 sample included a range of experience working with children (0-17 years), and within SDT (4-21 years).
317 All but one had published within the SDT area with a range from one to 32 SDT-related publications.

318 Procedure

319 The content of the MAT-PE tool is outlined in Table 2. Following training by the lead author, a
320 postgraduate student as well as the lead author administered the MAT-PE. Training lasted one hour
321 and covered all aspects of tool administration including the administration script, the assessment
322 process, activities and resources. The postgraduate student completed administration with two
323 children under the observation of the first author before administering the MAT-PE independently.

324 Throughout trialling the MAT-PE with the 85 children, the research team met every week over
325 the 6-week data collection period to discuss the tool's content validity. Discussions were noted by the
326 lead author and guided by COSMIN considerations around content validity (Terwee et al. 2018) and
327 reviewed the relevancy (were the questions relevant to the construct?), comprehensiveness (was each
328 aspect supported conceptually in accordance with the theoretical framework?) and comprehensibility
329 of the activities (did the children understand the activities and what they were supposed to do?).

330 Independent SDT researchers were sent a matching task (Hambleton, 1980 in Dunn et al.,
331 1999) via email to ascertain content validity. In order to complete the task, researchers had to match
332 each question/stem with the corresponding construct (enjoyment, relatedness, autonomy,

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333 competence, intrinsic, identified, introjection, external approach, external avoid and amotivation).
334 They were also asked, on a scale from one to five, to rate each item on how relevant (1=poor match,
335 2=fair, 3=good, 4=very good, 5=excellent match) and comprehensive (1=poor comprehensiveness,
336 2=fair, 3=good, 4=very good, 5=excellent comprehensiveness) each item was within that construct.
337 Matching scores for each item was determined through the number of researchers out of the sample
338 who correctly aligned it with the designated construct within the MAT-PE, culminating in a percentage
339 score. Mean scores were calculated for relevance and comprehensiveness.

340

Results

341 The MAT-PE required approximately 25 minutes to administer (not including the 30-minute
342 classroom drawing task). The research team reached consensus that the MAT-PE elicited sufficient
343 depth from the children according to their enjoyment of PE, their BPNS and behavioral regulation. It
344 was decided that the tool was *relevant* as all activities were judged to include aspects pertinent to
345 each theoretical construct and were representative of an early primary school PE context;
346 *comprehensive* as all activities encompassed sufficient components to ensure key considerations of
347 BPNS and behavioral regulation were assessed to the fullest extent possible in this age group (e.g.
348 inclusion of PE teacher and peer groups within the relatedness activity; addition of follow-up questions
349 related to cognitive autonomy, i.e. choice over activities and movement), and *comprehensible* as
350 activities were familiar and understood by the children (e.g. drawing, sorting, choosing). Therefore,
351 consensus among the research team, via COSMIN guidelines, that content validity was reached.

352 Table 3 shows the content validity matching task results. Eleven of the 19 questions/stems
353 were matched to the corresponding construct by at least 75% of the researchers (items 3, 4, 5, 7, 8,
354 12, 13, 14, 17, 18, and 19); five of which were matched by 100% of the researchers (items 7, 8, 17, 18,
355 and 19); four items by around half of the researchers (55.55-66.66%; items 2, 6, 9, and 16), and four
356 items by a third of the researchers or less (11.11-33.33%; items 1, 10, 11, and 15). The majority of
357 items were judged to be “good” (score of 3) or above for relevance and comprehensiveness. Item 1
358 was matched by a third of the researchers and item 11 by one researcher, however, both items were

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359 judged as “very good” on relevance and comprehensiveness. Item 10 was also matched by a third of
 360 the researchers, however, it was judged as “good” on relevance and “fair” on comprehensiveness.
 361 Stem 15 was matched by two researchers and judged to have “excellent” relevance and “good”
 362 comprehensiveness.

Table 3*Matching percentage, relevance and comprehensiveness of the MAT-PE items and their constructs*

Construct	Question/Stem	Matching (%)	Relevance Mean (SD)	Comprehensiveness Mean (SD)
Enjoyment	1. Like PE	33.33	4.67 (.58)	4.50 (1.00)
	2. Dislike PE	55.55	4.25 (.50)	4.25 (.96)
Relatedness	3. Liked/Disliked by PE teacher	88.88	4.00 (1.07)	3.43 (1.13)
	4. Like/Dislike of PE teacher	88.88	3.62 (1.06)	4.17 (.98)
	5. Included/Excluded by peers	77.77	3.29 (1.11)	3.00 (1.09)
	6. Includes/Excludes peers	66.66	2.29 (.95)	2.71 (1.38)
Autonomy	7. PE equipment choice	100	4.56 (.73)	3.88 (1.55)
	8. Choice of movements	100	4.22 (1.09)	3.88 (1.55)
	9. Choice of activities	66.66	4.50 (.84)	4.00 (1.73)
	10. Listened to by PE teacher	33.33	3.67 (.58)	2.67 (1.53)
	11. PE teacher answers questions	11.11	4.00*	4.00*
Competence	12. Self-rating of FMS	88.88	4.11 (1.27)	3.86 (1.07)
Intrinsic	13. I do PE because it's fun	88.88	4.63 (1.06)	4.83 (.41)
Identified	14. I do PE because I want to be healthy and strong	77.77	4.29 (1.25)	4.00 (1.55)
Introjected	15. I do PE because I want my PE teacher and classmates to like me	22.22	5.00 (.00)	3.50 (2.12)
Introjected	16. Do you ever feel like you need to do PE to show other children and your teacher how good you are PE?	55.55	4.40 (.89)	4.25 (1.50)
External approach	17. I do PE because I might get a reward	100	4.44 (.73)	4.63 (.74)
External avoid	18. I do PE because I don't want to get into trouble	100	4.88 (.35)	3.86 (1.68)
Amotivation	19. I don't want to do PE	100	4.67 (.71)	4.25 (1.16)

Note. SD = Standard Deviation, * = data from one person therefore Standard Deviation could not be computed for that item

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364

Study 2: Development, content validity, acceptability and reliability of the MAT-PE codebook

366 Study 2 was concerned with developing an approach to enable the mixing of quantitative
 367 (fixed choice selection) and qualitative (open-ended question responses) MAT-PE data for analysis
 368 (Creswell & Plano Clark, 2011). In the present study, the quantitative strand took priority as the
 369 qualitative strand helped to explain and illustrate the quantitative data (Bryman, 2006). Furthermore,
 370 a quantitative priority for analysis was sought in order to facilitate the statistical investigation of

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371 motivational profiles, the antecedents and consequences of motivation, and to provide numerical
372 data that could be analysed in longitudinal and experimental research. Thus, quantitative content
373 analysis (Rourke & Anderson, 2004) was selected as this is an acceptable form of deductive analysis
374 for semi-structured interviews and can be used to count the frequency and intensity of responses. An
375 important stage of quantitative content analysis is to establish a coding scheme that allows testing of
376 hypotheses (Rourke & Anderson, 2004; White & Marsh, 2006). Therefore, Study 2 aimed to develop a
377 'codebook' for researchers so that the transcript data from the MAT-PE could be analysed by coding
378 young children's motivational perceptions towards PE, mixing the quantitative and qualitative strands.
379 Furthermore, this study aimed to examine the content validity and acceptability of the developed
380 codebook, and determine inter-rater and intra-rater reliability.

381 Development of the MAT-PE codebook

382 Six members of the research team (KFD, PW, JR, SR, FB, LF) from the MAT-PE development
383 were involved in creating the codebook and provided the necessary skill, labour, thinking and energy
384 (Fernald & Duclos, 2005). Following previous research (Fonteyn et al., 2008; MacQueen et al., 1998),
385 the codebook was developed through an iterative process and structured similarly. The research team
386 met on six occasions over a three-month period to review and refine the codebook. This included
387 confirming codes, determining coding, and checking for ambiguous wording in code descriptions. In
388 the final step, four of the research team (KFD, JR, SR, LF) coded the same transcript data and found
389 few discrepancies in coding. Thus, consensus was reached among the research team that the
390 codebook development process was complete.

391 The final MAT-PE codebook (Supplementary Material D) was scaffolded and underpinned by
392 SDT and included codes (numerical), code descriptions and code examples. A coding table was
393 included with predetermined categories for each construct within the MAT-PE: enjoyment,
394 relatedness, autonomy, competence need satisfactions and behavioral regulation. Codes for each
395 motivational construct were initially created by reading through randomly selected transcript data
396 from Study 1.

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397 Codes were numerical, whereby higher values indicated higher levels of motivational
398 perceptions. This quantitative content analysis (White & Marsh, 2006) approach was used in order to
399 understand and describe motivational perceptions in a way that can be counted, quantified and
400 therefore measured. The numerical scoring process was designed to take into account the child's
401 initial quantitative response/choice (the 'what': yes or no, this or that) alongside the qualitative nature
402 of the child's answer (the 'why'), and whether the child provided a surface level (gave no more detail
403 to their initial answer) or deep level response (gave more detail to their initial answer) to the
404 researcher's questions. Deep level responses were taken to indicate stronger motivational
405 perceptions whereas surface level responses were taken to indicate weaker motivational perceptions.
406 Positive and negative aspects of each construct were therefore merged within the same coding matrix.
407 For example, in the relatedness activity children chose between being included or excluded by peers
408 in PE. Responses were put on the same coding scale from the most negative (scored 1: excluded, deep
409 level response) to most positive (scored 4: included, deep level response). Code descriptions outlined
410 the choice and depth of response for each code, while code examples included direct quotes from
411 children's actual transcript data, providing authenticity. Examples of coding for a child who picked a
412 positive option and gave a deep-level response for the relatedness activity can be seen in Table 4.

413 Overall construct scoring differed by construct: enjoyment score was calculated by taking the
414 coding given in "Like of PE" and subtracting the coding given in "Dislike of PE" which provided a range
415 from -3 to +3. Codes from all four relatedness responses were added together to create the overall
416 relatedness score, giving a range from 4 to 16. The same was done for autonomy where all four
417 responses were added to create the overall autonomy score, giving a range from 4 to 15. Competence
418 included one item only and therefore constituted the overall score (1-9). For autonomous motivation,
419 the coding given for intrinsic and identified regulations were added and then divided by two to obtain
420 the mean. For controlled motivation, first the coding for external regulations (approach and
421 avoidance) were added and then divided by two to obtain a mean.

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Table 4

An example of coding from the MAT-PE codebook

Relatedness Satisfaction | Liked/Disliked by PE Teacher | Activity 2a

Question(s): *This girl's/boy's PE teacher likes her very much, this girl's/boy's PE teacher doesn't like her very much, which girl/boy are you most like?*

Follow-up question(s): *How do you know your teacher likes/doesn't like you?*

Code	Description	Example
4✓	The child has chosen "liked by teacher" and articulates a deep level response as to how they know that.	R: "How do you know your PE teacher likes you?" → C: "Because sometimes he says good work" → C: "Because she never gets angry at me and she lets me help her" → C: "Because I do good work."
3	The child has chosen "liked by teacher" and articulates a surface level or irrelevant response as to how they know that.	R: "How do you know your PE teacher likes you?" → C: "They just do." → C: "Everyone is supposed to like everyone." → C: "Because I like ice cream." → C: "I don't know."
2	The child has chosen "disliked by teacher" and articulates a surface level or irrelevant response as to how they know that.	R: "How do you know your PE teacher doesn't like you?" → C: "I don't know." → C: "Because I like ice cream." → C: "I don't know."
1	The child has chosen "disliked by teacher" and articulates a deep level response as to how they know that.	R: "How do you know your PE teacher doesn't like you?" → C: "Because he be mean to me" → C: "Because sometimes he says I'm naughty."
N/A	The child has failed to choose between the two options and has not articulated toward which choice they feel more affinity with when prompted by the researcher.	The child may choose both or neither to obtain an N/A.

Coder's comments (e.g. if they provided an irrelevant response, any notable comments):

"A: Erm, because she smiles at me all the time... She doesn't pull angry faces at me"

Child has described **how** they know the PE teacher likes them and therefore the response is considered a deep-level response.

DEVELOPMENT AND VALIDITY OF THE MAT-PE

423 This mean was then added to introjection and then divided by two to obtain a mean for overall
424 controlled motivation. Amotivation included one item only and therefore constituted the overall
425 score.

426 Content validity and acceptability of the MAT-PE codebook**427 Methods****428 Participants**

429 Four individuals (50% female) with a range of SDT experience, who were independent of the
430 research team, were asked to use the codebook to code a transcript from Study 1. Two of the coders
431 were academics in psychology/sport coaching with 10-11 years of experience in their area of interest.
432 The other two coders were post-graduate psychology students with 4 to 6 years in their area of study.

433 Procedure

434 A brief explanation of how the MAT-PE is administered was given to participants before being
435 asked to read the instruction manual. Participants were given time to code the designated transcript
436 and were asked to note down any thoughts or queries that they had whilst using the codebook so that
437 they would not have to rely on recall. Each participant was asked a series of content validity and
438 acceptability questions regarding each part of the codebook. Content validity questions referred to:
439 relevance (*Is the code table relevant for the construct of interest? Are all code options independent of*
440 *each other with no overlapping or ambiguous descriptions and examples?*) comprehensiveness (*Are*
441 *there any key concepts not covered by the codes?*) and comprehensibility (*Are the instructions*
442 *understandable? Is the language used in the code table understandable?*) (Terwee et al, 2018).
443 Acceptability questions (*Were any sections difficult to complete? Would you change anything in the*
444 *code table to improve it?*) investigated the codebook's appropriateness. Responses were captured
445 through participants writing their answers to each question followed by a discussion between the
446 researcher and participants, which was recorded via Dictaphone. Written answers were inputted into
447 a spreadsheet and the lead author listened to the recorded discussions and added any extra
448 information, which was provided verbally, into the spreadsheet.

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Results

Coding took approximately 30 minutes (including reading of transcript, allocation of codes). All four individuals who completed the codebook content validity and acceptability agreed that for each construct (enjoyment, relatedness, autonomy, competence and self-regulation) the codebook was relevant, comprehensive and comprehensible. When asked if they had any recommended changes that would make the codebook easier to use, the feedback included: to provide more examples (enjoyment), put in place a way to keep track of the chosen equipment (autonomy), and to label the type of motivation in the instruction booklet (behavioral regulation). These recommendations were taken on board and the codebook was amended.

Inter-rater and intra-rater reliability of the MAT-PE codebook**Methods****Participants**

Three individuals (100% female) with SDT knowledge were asked to determine inter-rater reliability of the codebook. These individuals consisted of a post-graduate student who had helped determine acceptability of the codebook, an academic and researcher in the area of psychology and SDT (second author) and the first author.

Measures and procedure

To determine inter-rater reliability, each individual was given the codebook, the instruction manual and eight transcripts from eight different children provided through the MAT-PE tool. Transcript data consisted of verbatim responses from children collected during the MAT-PE administration. Transcripts were randomly selected via a computerised number generator to include four from Study 1 and four from a later time point (Study 3). Intra-rater reliability was examined by investigating the consistency between codes when the same eight transcripts were coded by the first author on two separate occasions one week apart.

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475 **Data analysis**

476 Statistical tests were completed using SPSS, version 24 [IBM SPSS Statistics Inc., Chicago, IL,
477 USA]. For inter-rater and intra-rater reliability (IRR), intraclass correlation coefficients (ICC), two-way
478 mixed single measures for absolute agreement with 95% confidence intervals (95% CI), were used to
479 determine the level of agreement between three raters (inter-rater reliability) and between two time
480 points (intra-rater reliability). The IRR was interpreted with cut-offs set at less than 0.40 (poor), 0.40
481 to 0.59 (fair), 0.60 to 0.74 (good) and 0.75 to 1.0 (excellent; Cicchetti, 1994).

482 **Results**

483 Inter-rater reliability for PE enjoyment, relatedness, autonomy, competence, autonomous
484 motivation, controlled motivation all had an ICC above 0.9, which is considered excellent (Cicchetti,
485 1994). As there was zero variance in the coding for amotivation for all eight transcripts, no ICC could
486 be calculated for this construct. However, the scores had 100% agreement between the three raters.

487 Intra-rater reliability for PE enjoyment, relatedness, autonomy, competence, autonomous
488 motivation, controlled motivation all had an ICC above 0.9, which is considered excellent (Cicchetti,
489 1994). As there was zero variance in the coding for amotivation for all eight transcripts, SPSS could not
490 generate an ICC for this construct, however the scores had 100% agreement from test-to-retest.

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492 **Study 3: Construct validity of the MAT-PE**

493 Construct validity is an important measurement property for evaluating outcome measures
494 (Prinsen et al., 2016). Study 3 therefore aimed to explore the construct validity of the MAT-PE through
495 hypothesis testing using correlational data. Following SDT research (Ryan & Deci, 2017; Sebire et al.,
496 2013; van Aert et al., 2017), broadly we hypothesised that 1) BPN will positively associate with each
497 other, 2) BPN will positively associate with autonomous regulations and negatively associate with
498 controlled regulations and amotivation, 3) introjection will demonstrate complex associations with
499 the other variables, and 4) behavioral regulations will ascribe to the simplex model (Ryan & Connell,
500 1989). Descriptive data is also presented to illustrate the data that can be collected from the MAT-PE

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501 and its codebook. Data was collected during post-test assessments of the cluster-RCT (Rudd et al.,
502 2020).

503 **Method**

504 **Participants**

505 Participants involved in Study 1 also formed a convenience sample for this study. Seventy-
506 eight children (male=48.7%, White British=57.7%, age_m=6.34 years, SD=0.30) took part. Seven children
507 from Study 1 did not take part in this study due to being absent on assessment days or leaving school.

508 **Measures and Procedure**

509 MAT-PE was used with each child in accordance with the procedures outlined in Study 1. The
510 codebook developed in Study 2 was used to code the transcript data obtained from the 78 children.
511 The first author and two trained postgraduate students administered the MAT-PE with children and
512 the first author coded the data with the codebook (ICC above 0.9).

513 **Data analysis**

514 All statistical tests were completed using SPSS, version 24 [IBM SPSS Statistics Inc., Chicago,
515 IL, USA]. The numerical codes for each theoretical construct, assigned using quantitative content
516 analysis as outlined in the MAT-PE codebook, were used in data analysis (higher numerical codes
517 represented stronger motivational perceptions). Descriptive statistics were computed for the overall
518 sample. Median values and inter-quartile ranges were used for descriptives due to the categorical
519 nature of the data. Wilcoxon signed rank tests were conducted to investigate differences in behavioral
520 regulation choices. A Kendall's tau-b correlation was run to determine the relationships between
521 BPNS, behavioral regulation and enjoyment as captured by the MAT-PE (Table 7). Kendall's statistic
522 was used due to the small sample size and it is said to be a better estimate of the correlation in the
523 population in comparison to Spearman's statistic (Howell, 1997). Following COSMIN guidance, the
524 results describe the direction and magnitude of relationships and avoided reporting p values, which
525 are affected by sample size (Mokkink et al., 2012).

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Results

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The MAT-PE descriptive data for the overall sample is presented in Table 5. The median, inter-

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quartile ranges and minimum and maximum scores indicate that children chose a variety of responses,

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demonstrating that all choices were valid.

Table 5

Descriptive statistics for N=78 children on the MAT-PE Version 1.

Code construct (PSR)	Min	Max	Median (IQR)
Enjoyment (-3 to +3)	-1	+3	0.00 (0.00,3.00)
<i>Like PE (1-4)</i>	2	4	4.00 (4.00,4.00)
<i>Dislike PE (1-4)</i>	1	4	4.00 (1.00,4.00)
BPNS Total (9-40)	25	39	35.00 (34.00,37.00)
Relatedness (4-16)	11	16	15.00 (15.00,16.00)
<i>Liked by PE teacher (1-4)</i>	3	4	4.00 (4.00,4.00)
<i>Like of teacher (1-4)</i>	3	4	4.00 (4.00,4.00)
<i>Inclusion by peers (1-4)</i>	1	4	3.50 (3.00, 4.00)
<i>Inclusion of peers (1-4)</i>	1	4	4.00 (4.00,4.00)
Autonomy (4-15)	7	15	11.00 (11.00,13.00)
<i>Pictorial (1-6)</i>	2	6	4.00 (4.00,6.00)
<i>Move/activities (1-3)</i>	1	3	1.00 (1.00,2.00)
<i>Listened to (1-3)</i>	1	3	3.00 (3.00,3.00)
<i>Questions answered (1-3)</i>	1	3	3.00 (3.00,3.00)
Competence (1-9)	2	9	9.00 (8.00,9.00)
Autonomous (1 to 5)	1	5	3.50 (3.00,4.00)
<i>Intrinsic (1-5)</i>	1	5	3.00 (3.00,5.00)
<i>Identified (1-5)</i>	1	5	3.50 (3.00,5.00)
Controlled (1 to 5)	1	4.5	2.25 (1.50,2.75)
<i>External reward (1-5)</i>	1	5	3.00 (2.00,4.25)
<i>External punishment (1-5)</i>	1	4	1.00 (1.00,2.00)
<i>Introjection (1-5)</i>	1	5	2.00 (1.00,3.00)
Amotivation (1-5)	1	5	1.00 (1.00,1.00)

Note. PSR = Possible Score Range, BPNS = Basic Psychological Needs Satisfaction, Min = Minimum, Max = Maximum, IQR = Inter Quartile Range. Autonomous and controlled motivation scores are mean scores of the sub-constructs within them (e.g., Autonomous motivation = (intrinsic + identified)/2) with higher scores indicating stronger motivation

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Enjoyment

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For enjoyment, while the group median value was 0, the interquartile range (IQR) indicates

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that 75% of coding fell between 0 and 3 (maximum score), signifying that overall, the majority of

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children enjoy PE to a greater extent than they dislike PE.

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DEVELOPMENT AND VALIDITY OF THE MAT-PE

538 **Basic Psychological Need Satisfaction**

539 For the overall sample, the median value was 35 with 75% of coding between 34 and over
 540 (maximum score 39). Higher coding in the majority of the sample of this summary construct indicate
 541 that overall, all three basic psychological needs are highly satisfied. The overall competence and
 542 relatedness median codes and IQR indicated that these basic psychological needs were highly satisfied
 543 within the majority of the sample. The overall autonomy median and IQR values indicate that the basic
 544 psychological need for autonomy was moderately satisfied within 50% of the sample, and highly
 545 satisfied in 25% of the sample (see Table 5). High levels of procedural and organisational autonomy
 546 need satisfaction were found in the majority of the sample for *choice of equipment and peers* (pair-
 547 and/or group-work) in the pictorial activity. Lower median codes and IQR values were found for
 548 cognitive autonomy need satisfaction in terms of choice of movement/activities in PE with 75% of
 549 coding falling at 2 and under (maximum of 3).

550 **Behavioral regulation**

551 As shown in Table 6, the most popular behavioral regulations for taking part in PE were
 552 intrinsic, identified and external reward (87.17%, 84.62%, 79.49% respectively) with introjected and
 553 external punishment as less popular behavioral regulations for taking part in PE (66.67% and 33.33%
 554 respectively). The least chosen was amotivation (2.56%). At *least* a third of the sample ranked an
 555 autonomous form of motivation as their first choice and at *most* a third of the sample chose a
 556 controlled form of motivation as their first choice for taking part in PE.

Table 6

Number and percentage of behavioral regulations chosen overall, as first choice, as other choice and not picked by children

Type of regulation	No. of children (Total _n =78)	1 st choice	"other" choice	Not Picked
Autonomous Motivation				
Intrinsic	68 (87.18%)	26 (33.33%)	42 (53.85%)	10 (12.82%)
Identified	66 (84.62%)	39 (50.00%)	27 (34.62%)	12 (15.38%)
Controlled Motivation				
Introjected	52 (66.67%)	6 (7.69%)	46 (58.97%)	26 (33.33%)
External reward	62 (79.49%)	23 (29.49%)	39 (50.00%)	16 (20.51%)
External punishment	26 (33.33%)	3 (3.85%)	23 (29.49%)	52 (66.66%)
Amotivation	2 (2.56%)	1 (1.28%)	1 (1.28%)	76 (97.44%)

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557 High percentages of children gave deep level responses (verbally provided more detail to their
558 fixed choice selection) for choosing amotivation, external reward, intrinsic and identified (100%,
559 85.48%, 85.29% and 84.85% respectively) reasons. A reasonable number of children provided deep
560 level responses for introjection (65.38%) while less than half gave deep level responses to external
561 punishment (48%). Children had six types of behavioral regulations to choose from and their number
562 of choices varied: 35.90% chose four regulation types, 23.80% chose five and 20.51% chose three
563 regulation types, 12.82% chose two types of regulations, and 6.41% chose one type of regulation. No
564 child chose all regulation types, and this variance in choices demonstrates that children can
565 differentiate between the different types of regulations, as well as being able to provide deep level
566 responses. To view a Figure that shows the variance in the number of behavioral regulations across
567 the sample, please see Supplementary Material E.

568 Autonomous and Controlled motivation

569 The overall autonomous motivation median and IQR values indicate that the majority of
570 children were experiencing moderately high levels of autonomous motivation. The overall controlled
571 motivation median and IQR values indicate that the majority of children were experiencing low to
572 moderate levels of controlled motivation in PE. A Wilcoxon signed-rank test showed a statistical
573 difference between external positive regulation and external negative regulation ($Z=-6.69$, $p<0.001$),
574 external positive regulation and introjected regulation ($Z=-3.94$, $p,0.001$), and external negative and
575 introjection ($Z=-5.21$, $p<0.001$). This indicates that the types of controlled regulations were chosen
576 and responded to differentially.

577 Amotivation

578 The overall amotivation median and IQR values indicate that although amotivation is very low
579 in this sample, it is still present.

580 Construct validity: Hypothesis testing

581 Correlational data for the MAT-PE is presented in Table 7.

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Table 7*Kendall's tau-b Correlational Matrix between Enjoyment, Basic Psychological Needs, and Behavioral Regulation Constructs captured by the MAT-PE.*

N = 60	1	2	3	4	5	6	7	8	9	10
1. Enjoyment	-									
2. Relatedness	.07 (-.16 - .30)	-								
3. Autonomy	.04 (-.20 - .29)	.24 (.04 - .41)	-							
4. Competence	-.04 (-.27 - .21)	.23 (-.01 - .45)	.14 (-.11 - .36)	-						
5. Intrinsic	.12 (-.10 - .35)	.13 (-.11 - .38)	.02 (-.23 - .27)	.09 (-.17 - .35)	-					
6. Identified	-.09 (-.31 - .14)	.01 (-.23 - .25)	.01 (-.22 - .24)	.09 (-.16 - .32)	-.24 (-.50 - .00)	-				
7. External app.	.12 (-.11 - .36)	.11 (-.12 - .32)	.04 (-.22 - .29)	.29 (.08 - .49)	-.05 (-.26 - .18)	-.08 (-.32 - .15)	-			
8. External avo.	-.04 (-.30 - .20)	.16 (-.09 - .39)	.05 (-.19 - .24)	.00 (-.23 - .22)	.17 (-.10 - .42)	.12 (-.10 - .33)	.24 (.04 - .44)	-		
9. Introjected	.08 (-.13 - .31)	.09 (-.15 - .31)	.24 (.03 - .42)	.12 (-.13 - .35)	.19 (-.04 - .44)	.15 (-.16 - .41)	.28 (.09 - .48)	.40 (.18 - .60)	-	
10. Amotivation	-.12 (-.24 - -.05)	-.14 (-.30 - -.01)	-.16 (-.30 - -.06)	-.21 (-.38 - -.09)	-.27 (-.43 - -.17)	-.04 (-.32 - .22)	-.13 (-.29 - .02)	-.12 (-.22 - -.07)	-.19 (-.32 - -.12)	-

Note. Brackets include bias corrected accelerated confidence intervals set at 95% with 1000 bootstraps; app. = approach, avo. = avoidance.

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583 ***Hypothesised/Expected relationships***

584 Small but positive associations were found between all three BPN (.14 to .24). There were also
585 a small, positive association between relatedness need satisfaction and intrinsic regulation (.13). All
586 other associations between BPNS and the autonomous types of regulations (intrinsic and identified)
587 were weak and under .10, although all were in the expected direction (positive). Introjection had a
588 small, positive association with identified regulation (.15). Introjection also had a small, positive
589 association with external (approach; .28); however, introjection had a stronger, positive association
590 with external (avoidance; .40).

591 There was a small, negative association between intrinsic regulation and amotivation (-.27).
592 Amotivation had weak to small, negative associations with enjoyment, all three BPN, intrinsic and
593 identified regulation (-.04 to -.27). The autonomous types of regulation and external (approach) had
594 negative associations under .10; however, associations were in the expected direction.

595 ***Unexpected relationships***

596 Relatedness needs satisfaction had small, positive associations with both external approach
597 and avoidance (.11 and .16, respectively). There was a small, positive association between
598 competence and external (approach; .29); however, there was no relationship between competence
599 and external (avoidance; .00). Autonomy need satisfaction and external (approach and avoidance)
600 regulation had associations below .10; however, the associations were in an unexpected direction
601 (positive).

602 A small, negative association between intrinsic and identified regulations (-.24) was found.
603 Intrinsic regulation also had small, positive associations with external (avoidance; .17) and introjected
604 regulation (.19). Identified regulation had a small, positive association with external (avoidance; .12).
605 amotivation had small negative associations with controlled types of motivation (-.12 to -.19).

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609 General Discussion

610 Despite the ability of young children to report on their own experiences (Stone & Lemanek,
611 1990), and their suspected ability to differentiate between motivational constructs (Butler, 2005; Guay
612 et al., 2010), there is a distinct lack of appropriate tools to measure young children's motivation
613 (Sebire et al., 2013), particularly within PE. This paper reported the development and content validity
614 of the MAT-PE and its associated codebook and presented preliminary descriptives and an exploration
615 of construct validity, as guided by COSMIN (Mokkink et al., 2010; Mokkink et al., 2012; Terwee et al.,
616 2018). Study 1 developed the Motivation Assessment Tool for Physical Education (MAT-PE), a mixed-
617 method, age-appropriate tool for assessing 5-6-year-old children's motivation for PE, and found the
618 tool was judged to have promising content validity. Study 2 developed a codebook to analyse
619 transcript data from the MAT-PE. The codebook was found to be acceptable by researchers with
620 differing SDT experience, judged to have content validity and demonstrated excellent inter- and intra-
621 rater reliability. Study 3 presented illustrative MAT-PE data that showed that children had high
622 enjoyment, relatedness and competence need satisfaction and lower autonomy need satisfaction.
623 Children also had moderate to high autonomous motivation, low to moderate controlled motivation
624 and low amotivation. Finally, children's MAT-PE data demonstrated a mixture of expected and
625 unexpected relationships in accordance with hypothesis testing for construct validity. The following
626 sections provide a detailed discussion of these findings and their implications for the MAT-PE tool.

627 Content validity

628 Content validity is arguably the most important psychometric property to determine
629 suitability of a measurement tool, as without content validity, other types of validity cannot be
630 conducted (Prinsen et al., 2018). According to COSMIN (Terwee et al., 2018), a tool has good content
631 validity when its items and instructions are relevant, comprehensive and comprehensible. The
632 involvement of the target population (Wiering et al., 2017) led to a tool which comprehensively
633 captures BPNS and behavioral regulations in PE - including distinct assessments of introjected and
634 external regulations which were collapsed in previous measures (Guay et al., 2010). Comprehensibility

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635 was demonstrated by the children who were able to pick from the different types of regulation, and
636 also provide deep level responses to the follow-up questions. Follow-up questions were put in place
637 to ascertain children's level of understanding around these different types of behavioral-regulation
638 and informed researchers as to why they partook in PE. Content validity was further tested through
639 independent researchers with expertise in SDT who completed a matching task and rated each MAT-
640 PE item on its relevance and comprehensiveness. Although 11 of the 19 items were matched to the
641 intended construct by at least 75% of the researchers, there were four items that were matched by
642 between 55.55% and 66.66%, and four items that were matched by less than 50% of the researchers.
643 This suggests that the MAT-PE tool shows promise of content validity and theoretical fidelity. Yet, as
644 discussed below in relation to each construct, eight items were potentially problematic and may
645 require further development.

646 *Enjoyment*

647 PE enjoyment was included in the MAT-PE as enjoyment is positively related to actual PA, PA
648 intention and high levels of motivation (Best et al., 2017; Bungum et al., 2000; Yli-Piipari et al., 2009).
649 "Like of PE" and "Dislike of PE" items were matched to the enjoyment construct by only 33.33% and
650 55.55% of the independent researchers, respectively. It is interesting that "Dislike of PE" was matched
651 more successfully than "Like of PE". "Like of PE" might have been perceived by the independent
652 researchers to relate to intrinsic motivation to a greater extent than enjoyment. Enjoyment is a
653 significant part of intrinsic motivation (Deci & Ryan, 1991). Enjoyment can also be viewed as a
654 standalone construct, which has a history of challenge in its definition and use (Kimiecik & Harris,
655 1996). Perhaps these findings indicate an issue with the matching task methodology, as there would
656 be an assumed association between enjoyment and intrinsic motivation. The advantage of retaining
657 these enjoyment items in the MAT-PE is that enjoyment of PE can be understood in its own right. If
658 the researcher is not interested in PE enjoyment, these items could be omitted from administration
659 of the tool without impacting perceptions of intrinsic motivation. Removing the enjoyment items and
660 the associated write and draw activity would also reduce MAT-PE administration time.

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661 **Relatedness**

662 “Liked/Disliked by PE teacher” and “Like/Dislike of PE teacher” were matched highly by the
663 independent researchers (88.88% respectively). Matching percentage was lower, however, for the
664 peer related items (“Included/Excluded by peers” and “Includes/excludes peers”). The item which
665 focused on children including others was matched lower than the item focused upon being included
666 by others. It was decided to include the former item as Ryan and Deci (2017) state that “Relatedness
667 refers to both experiencing others as responsive and sensitive and being able to be responsive and
668 sensitive to them...” (p.86). This implies a two-way meaningful interaction between social agents and
669 consequently it would be pertinent to retain the item. As such, it would be advantageous to include
670 both types of questions per social agent (i.e., included/excluded *by* peers and includes/excludes *of*
671 peers). A recent systematic review and meta-analysis reported differential effects of teachers and
672 peers on relatedness need satisfaction (Vasconcellos et al., 2019), indicating that peer items should
673 be retained in the MAT-PE tool.

674 **Autonomy**

675 Within autonomy, it was interesting that choice over equipment and movements was
676 matched by 100% of the independent researchers while choice over activities was only matched by
677 66.66%. It is not clear why the activity choice item was not matched as much as the other choice items
678 as it was phrased in the same way. The autonomy construct was limited to choice and lacked a
679 measure of volition. Despite this lack comprehensiveness in the construct, choice is a significant factor
680 of autonomy as demonstrated by De Meester et al. (2020) who found that providing 12-13-year-old
681 children with choice in activity, level, pace and with whom they wanted to work with may have
682 positively impacted competence and relatedness need satisfaction.

683 “Listened to by teacher” and “PE teacher answers questions” were matched by 33.33% and
684 11.11%, respectively. In their comments, the independent researchers mentioned that this item was
685 around a choice of being listened to, which has been identified as an inclusive element of autonomy
686 items in other measures (Smith et al., 2015). “Listened to by teacher” was rated lower for relevance

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687 and comprehensiveness; however, it is also closely related to feelings of inclusivity within autonomy.
688 Despite this connection with theory, the tool may benefit in future by omitting these items in favour
689 of items around volition, which was not included within version 1 of the MAT-PE. For example, an item
690 could be developed based on an item from the children's version of the Basic Psychological Needs
691 Satisfaction and Frustration Scale "I do the things I do because I really want to do them" (BPNSFS; Van
692 der Kaap-Deeder et al., 2015).

693 Although the autonomy activity was predominantly based on children's perceptions of how
694 much choice they felt during their PE lessons, it could be contended that the language used within
695 these items lies somewhere between need satisfaction and need support. There is arguably a fine line
696 between perceptions of need support and need satisfaction when stemming from the participant self-
697 reporting (rather than a measure of need support via an external agent such as through observation).
698 The items were aimed at targeting the perceptions that the children felt rather than what was being
699 made available to them; however, it is unclear whether children of this age can tell the difference
700 between these two types of questions. Regardless, effort should be made in future to align the
701 wording of these MAT-PE items to reflect an inner process rather than an availability of support.

702 Competence

703 Although the competence item was highly matched by independent researchers, it would be
704 prudent to add additional items to further investigate younger children's competence perceptions.
705 The competence construct could be developed further by introducing other components, perhaps
706 based on items of the BPNSFS (Van der Kaap-Deeder et al., 2015), such as, "I am good at difficult
707 tasks", as currently competence is a global item centred on ability to perform fundamental movement
708 skills within version 1 of the MAT-PE, following the UK national curriculum aims for primary PE.

709 Behavioral regulation

710 All items were highly matched by independent researchers (77.77%-100%) except for items
711 of introjection based on Guay et al.'s (2010) motivation measure. "I do PE because I want my PE
712 teacher and classmates to like me" and "Do you ever feel like you need to do PE to show other children

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713 and your teacher how good you are at PE?” were matched by 22.22% and 55.55% of researchers,
714 respectively. One independent researcher commented that the former item seemed more external
715 than introjected. We would argue that the use of “I want” within the stem aims towards a more
716 internal rather than purely external drive. Introjection has often been presented within motivation
717 measures as a form of guilt (e.g., “I feel guilty when I don’t exercise”, Markland & Tobin, 2004). Sebire
718 et al. (2013) also tapped into guilt within their measurement of motivation within PA for 7.84- to
719 11.09-year-old children with the stem “*When I’m not active I feel bad*”. Within the current study, only
720 one child could provide a definition approaching guilt and the use of ‘feeling bad’ also caused
721 confusion. Feelings of guilt stem from relating affect to events with increasing social understanding
722 (Malti, 2016), which only occurs through experience. As young children may not have sufficient
723 opportunities to effectively form links between affect and events, feelings of guilt are perhaps less
724 appropriate than feelings of ego to capture introjection. Clearly, this is a challenging construct to
725 measure in this age group and there is a need to further develop this item. Further investigations into
726 this age group regarding introjected regulation would be advantageous for the field and SDT.

727 Construct validity

728 Small, positive associations between BPNS were found, which is in line with previous SDT
729 studies (Huhtiniemi et al., 2019; Ryan & Deci, 2017; Sebire et al., 2013). However, the associations in
730 this study were smaller in comparison to these studies, but consistent with some other studies with
731 children (e.g., van Aert et al., 2017). Although associations between BPNS and the autonomous types
732 of regulation (i.e., intrinsic and identified regulations) were in the expected direction (Deci & Ryan,
733 2000), associations were weak (<.10). Given that some of the autonomy need satisfaction items were
734 matched lowly, and considerations of the language used (support vs. satisfaction), these content
735 validity issues may explain some of the weak associations between autonomy and autonomous types
736 of regulation. It is unclear why relatedness and identified regulation had a positive but weak
737 association given that both relatedness and identified items were highly matched by independent
738 researchers and based on past research (e.g., Guay et al., 2010; Sebire et al., 2013).

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739 Introjection had a complicated set of associations with various constructs which aligns with
740 the partially internalised nature of introjection (Ryan & Deci, 2017). For instance, introjection was
741 positively associated with identified (autonomous) and external (controlled) regulations as well as
742 BPNS (Vasconcellos et al., 2019). However, there was a difference between the different types of
743 external regulation and introjection where external avoidance (i.e., fear of punishment) was more
744 (positively) strongly associated in comparison to external approach (i.e., chance for a reward). This
745 indicates that a child who seeks to avoid punishment is more likely to want to please their teacher and
746 peers. Amotivation was negatively associated with enjoyment, BPNS and autonomous types of
747 regulation which was to be expected (Gao et al., 2013; Vasconcellos et al., 2019).

748 Notably, the most unexpected association was the small, negative association between
749 intrinsic and identified regulation. Previous research has consistently found positive associations
750 between the two autonomous types of regulation (Gao et al., 2013; Huhtiniemi et al., 2019;
751 Ntoumanis, 2001; Sebire et al., 2013) which ascribe to the simplex model (Ryan & Connell, 1989). The
752 negative association found between intrinsic and identified regulations in this study indicates that the
753 more children perceive PE to be fun (intrinsic) the less likely they are to participate to be healthy and
754 strong (identified) and vice versa. It may be possible that children of 5- and 6-years of age perceive
755 these types of regulation as opposing. If they perceive PE to be highly fun, they may not feel that being
756 healthy and strong is as important and vice versa.

757 The separation of external regulation into approach and avoidance led to a small, positive
758 association between external approach and competence while there was no correlation between
759 external avoidance and competence. This is in contrast to other research which has found negative
760 correlations between external regulation (not split) and competence (Huhtiniemi et al., 2019; Sebire
761 et al., 2013; Vasconcellos et al., 2019), and against SDT theory which posits that controlled types of
762 motivation are negatively associated with BPNS (Ryan & Deci, 2017). The findings in this study indicate
763 that children who felt higher levels of competence felt that participation in PE was highly driven by
764 external rewards and vice versa. This indication may not be so surprising as the use of rewards in

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765 education is prevalent (Deci et al., 2001) and children are highly competence driven (Harter, 1988). It
766 may be that the recognition of rewards as controlling only emerges with age. Children of 5- and 6-
767 tend to have an undifferentiated concept of ability (i.e., ability and effort are perceived as the same;
768 Nicholls, 1984, 1989), therefore, if rewards are offered contingent upon participation then children
769 may attribute rewards for effort put in, rather than competence level.

770 Amotivation was unexpectedly negatively associated with the controlled types of regulation
771 (external and introjection). This may be because that in this study amotivation was only chosen by two
772 children within the sample. The rest of the children were given a code of 1 (not picked) and coded
773 higher for any other type of regulation they chose, automatically resulting in a negative association.
774 Further research is needed to explore the amotivation aspect as it could provide valuable information
775 for researchers and teachers on how to best support young children.

776 Taken together, this initial exploration into construct validity indicated that the tool was able
777 to capture some of the hypothesised associations between motivational variables, aligning with past
778 SDT research, though several unexpected relationships were also found. It is possible that the weak
779 relationships among BPNS and types of behavioral regulation observed in this study may change
780 across developmental time and this requires further investigation. Regardless, the correlations
781 observed in the current study should not be over-interpreted due to the small sample size. Future
782 research should seek to improve MAT-PE before examining construct validity with a larger, more
783 representative sample.

784 Preliminary descriptives the MAT-PE

785 Study 3 provided descriptive results from the MAT-PE and codebook that showed promising
786 sensitivity and range in this sample of children. Despite some motivational tools focusing upon
787 intrinsic motivation (Gottfried, 1986, 1990), collapsing introjection and external regulations (Guay et
788 al., 2010), and excluding amotivation, the MAT-PE demonstrates that when given the choice, young
789 children are capable of choosing the types of behavioral regulation underlying their participation in

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790 PE. Furthermore, children provided a wide range of need satisfaction responses, supporting the
791 potential of the tool in capturing high and low levels of basic psychological needs.

792 *Enjoyment*

793 This study found that most children perceived PE to be enjoyable. Of the limited studies
794 available for comparison, Baron and Downey (2007) found that PE enjoyment among 7-11-year-olds
795 was high for games, gymnastics and dance activities. PE has been rated as a top 3 favourite subjects
796 in 78% of children aged five to 12 (Coulter & Woods, 2011), which indicates high levels of enjoyment.
797 However, PE enjoyment has been found to decline from the age of nine (Cairney et al., 2012;
798 Prochaska et al., 2003). Therefore, is worth monitoring, especially as it has the potential to predict
799 actual PA and PA intention (Best et al., 2017; Bungum et al., 2000). Our findings are generally in line
800 with previous literature and suggest that the MAT-PE could be used by researchers to identify what
801 young children like and do not like about PE so as to best support overall PE enjoyment.

802 *Basic Psychological Need Satisfaction*

803 Overall, relatedness need satisfaction was high, which aligns with previous literature in older
804 age groups (13-14-year-olds, Ntoumanis et al., 2009; 11-16-year-olds, Taylor et al., 2010). The
805 relatedness items had a possible scoring range of one to four. Children's actual scores for the PE
806 teacher-related items ranged from three to four, while scores on the peer-related items ranged from
807 one to four. This wider range for peer-related items indicates that some children in this sample chose
808 the more negative options provided to them, indicating sensitivity of the tool and a lack of positive
809 bias on behalf of the children. Although the PE teacher-related items were matched more highly by
810 the independent researchers, we believe the inclusion of both social agents within the tool has the
811 potential to provide useful information. As stated above, this belief is supported by Vasconcellos et al.
812 (2019) who outlined that PE teachers and peers have differential effects upon children's relatedness
813 where peers have more of an effect on relatedness than PE teachers.

814 Overall, there was lower reported autonomy need satisfaction in comparison to relatedness
815 and competence needs satisfaction in this sample. The possible range for overall autonomy was four

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816 to 15 and the actual range was found to be seven to 15. All items demonstrated sensitivity as the
817 actual range was close to the possible range. This more moderate level of autonomy echoes the
818 literature based in older age groups (13-15-year-olds, Taylor & Lonsdale, 2010; nine- to 12-year-olds,
819 van Aart et al., 2017).

820 Consistent with previous research which examined perceived motor competence in 4-7-year-
821 old children (Noordstar et al., 2016; Spessato et al., 2013), competence need satisfaction was seen to
822 be high within this sample. However, the possible and actual ranges of the global item were similar,
823 indicating some sensitivity in this item among the sample.

824 Behavioral regulation

825 Particular sensitivity can be seen in the behavioral regulations aspect of the MAT-PE where
826 the possible and actual ranges were the same, except for external avoidance, which was seen to have
827 an actual range of one to four rather than the possible one to five. This indicates that some children
828 within the sample either did not pick each type of regulation or gave varying responses. Most children
829 were able to provide 'deep' level responses, indicating their comprehension of the items. There was
830 a higher level of autonomous motivation in comparison to controlled, which has been previously
831 found in younger children comparatively to older children (Corpus et al., 2009). However, controlled
832 motivation, or more specifically, external approach was highly present in the sample. This may be
833 because the use of rewards is considered prevalent within the education system (Deci et al., 2001).

834 Although only two children in our sample chose amotivation, they both provided deep level
835 responses to the follow-up question indicating that with larger samples it could be further explored
836 what forms of amotivation young children demonstrate in PE. Within a sample of 390 14- to 15-year-
837 olds, only 21 (15 girls, 6 boys) were identified as being amotivated within PE (Ntoumanis et al., 2004).
838 This suggests that the prevalence of amotivation is relatively low in younger and older samples of
839 children and adolescents. We would advocate the inclusion of the amotivation in future versions of
840 the MAT-PE.

841 Practical Implications and Future Research Directions

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842 As this is a first step towards developing a tool that can assess young children’s motivational
843 perceptions in PE, improvements to the tool are needed before more data collection is conducted in
844 a larger, representative sample. The MAT-PE has been shown to be feasible for a researcher to
845 administer one to one with a young child in a quiet location, and the resources are relatively low cost.
846 In all, with 30 minutes allocated to the draw and write classroom-based activity, ~20 minutes for the
847 remainder of the MAT-PE administration, ~60 minutes for transcription and ~30 minutes to code, this
848 equates to around 2 hours per child. Purely quantitative motivation measures have been seen to take
849 from 20-30 minutes to administer (Gottfried, 1990; Guay et al, 2010) on a whole-class basis, while one
850 to one measures, such as The Pictorial Scale of Perceived Movement Skill Competence for Young
851 Children (Barnett et al, 2015) and the Self-Perception Profile for Children (Harter & Pike, 1984)
852 designed for younger children takes less than 10 minutes to administer. Although the MAT-PE has an
853 arguably lengthy administration process, which could be considered a limitation by some, it is
854 worthwhile when considering the amount of depth and richness of data provided by young children.
855 Nevertheless, future research should examine strategies to reduce coding times such as conducting
856 live coding alongside the MAT-PE administration and/or directly coding from audio recordings without
857 transcription. Removing the Write and Draw enjoyment activity and undertaking live coding could
858 reduce the total administration time to around 20 minutes.

859 Also, although the tool itself is considered mixed-method, the data it produces can be
860 analysed qualitatively or quantitatively, making it accessible to different types of researchers and
861 research questions. Future studies should also include children with different language and special
862 educational needs (e.g., children with Autism) to assess its accessibility. Future research should also
863 examine further aspects of validity such as predictive validity, as well as test-retest reliability and
864 responsiveness. At this point the MAT-PE is primarily for researcher use, towards understanding young
865 children’s motivation, how and if it changes over time, the consequences of motivation in PE on other
866 outcomes such as PA, and to inform interventions. Although it is intended for researcher use, its use
867 within applied research and collaborative Higher Education/elementary education partnerships has

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868 relevance for informing teaching practice. This is important as PE teachers can identify children with
869 poor quality or no motivation and their source of motivation and subsequently understand how to
870 support their motivation through their own teaching styles.

871 Strengths and limitations

872 This study had several strengths including the comprehensive iterative development of the
873 MAT-PE and codebook with the relevant target populations over a period of 14 months. Strength was
874 also found in the variety of expertise within the research team, where content validity was judged
875 based on multi-disciplinary rather than narrow perspectives (Terwee et al., 2018). A further strength
876 was that independent researchers with a range of SDT experience were sampled in determining the
877 MAT-PE and codebook's acceptability and content validity, enabling the codebook's accessibility to be
878 assessed. Limitations included the involvement of the same children in Study 1 and Study 3. This was
879 due to the present study being conducted within a larger research project (Rudd et al., 2020) with a
880 convenience sample of children that could be accessed within the study timeline. This may have
881 influenced how the children in Study 3 interacted with the tool as it was familiar to them. A further
882 limitation may be attributed to the small number of questions for each SDT construct due to the young
883 age of the target population, which may restrict the comprehensiveness of the assessment.

884 Conclusion

885 This study was a first step towards a novel, mixed-method tool to measure young children's
886 BPNS and behavioral regulations in PE through an age-appropriate set of activities aligned with SDT
887 and informed by young children. The MAT-PE has promising content validity (Study 1), though further
888 development is needed, namely within the autonomy activity (e.g., language of items, addition of
889 volition items), and consideration of the introjected regulation item (i.e., is the ego aspect of
890 introjection better for investigation in this young age group in comparison to feelings of guilt/shame?).
891 The codebook (Study 2) was found to not only have content validity but it was also found to be
892 acceptable and demonstrated excellent reliability. The tool demonstrated some sensitivity, and
893 provided expected and unexpected associations between motivational constructs (Study 3), which

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894 requires further investigation. With further development and a larger sample, this tool has the
895 potential to allow researchers to explore how the PE environment affects young children's BPNS and
896 subsequent behavioral regulation. Knowing this information can inform interventions on a class level
897 (changing the environment to support BPN) and to identify individual children who may be
898 experiencing controlled motivation or amotivation. Through this, research can help inform teachers
899 motivating styles and their practice within early primary PE.

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