Development and further validation of the Motivation Assessment Tool for Physical Activity (MAT-PA) among children with autism spectrum disorder

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Abstract

Purpose This study describes the content validity process, focusing on children, to create and validate a tool for assessing motivation toward out-of-school physical activity (PA) among children with autism spectrum disorder (ASD) aged 6 to 17 years. Additionally, it establishes the eligible verbal communication age range necessary for its application. The initial development and content validity process with external experts is described elsewhere (An et al., under review).

Methods The MAT-PA was iteratively refined during the content validity process by administering it to twenty children, including two using MAT-PA (version 0.1), ten using MAT-PA (version 0.2), and eight using MAT-PA (version 0.3). Modifications were made based on feedback from children who completed the entire interview. The Vineland Adaptive Behavior Scales, Second Edition (VABS-2), assessed the age-equivalent for daily verbal communication skills required for the MAT-PA.

Results Feedback from the twelve children who completed the entire interview process (two with version 0.1, six with version 0.2, and four with version 0.3) provided evidence supporting the tool's content validity. Challenges with attention spans and verbal abilities limited full participation from the remaining eight children. Parent-reported VABS-2 scores indicated that the MAT-PA is suitable for children with ASD who have verbal communication skills equivalent to 3-year-olds (receptive) and 6-year-olds (expressive).

Conclusion The MAT-PA is the first tool specifically designed to explore motivational processes of children with ASD, demonstrating promising content validity. Future work should focus on improving the tool's reliability for trial integration, exploring its applicability across diverse contexts, and leveraging technology to boost scalability and impact.

Keywords Self-Determination Theory, Out-of-school physical activity, Autism spectrum disorder, Children, Motivation, Assessment

Acknowledgements

The authors would like to thank the parents and children, as well as the external experts, for participating in this study. The authors also thank the school principals and vice principals, Naoko Hino (after-school day care: Little Oranges), Ayako Miyanohara, Hikaru Hashiguchi, Riko Nishida (after-school day care offered by Good Job Groups through Sakura-bio Co., Ltd.), Kaeko Miyauchi (Autism Society of Kyoto), Noriko Nakagawa (ONLY ONE—Parents Association for ASD in Kyoto), Terumasa Kawano (after-school day care: Social Welfare Corporation Tsuitachi), Moto Ikezoe (after-school day care: Fukushi Hiroba), Kazuki Doi (after-school day care/rehabilitation studio for developmental disorders: Happy Ring Service Group), Hisatsugu Sasai (after-school day care: TOMOMO) for their help with the recruitment of parents and children. The authors would also like to thank Dr. Xitong Liao for designing the pictorial resources. Additionally, the authors would like to thank Dr. Hiroyuki Inadomi and Mrs.Mariko Sasai for their support. The first author would like to give special thanks to her parents, Dr. Anqiang Xiang and Mrs. Chengzhi Xie, for their unwavering support.

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Statements and Declarations

Conflict of interest: The authors have no competing interests to declare that are relevant to the content of this article.

Ethical Approval: All procedures undertaken in the current study were in accordance with ethical standards and received approval from Ethics Committee, Graduate School and Faculty of Medicine, Kyoto University (R4063-2).

Informed Consent and Informed Assent: Informed Consent was obtained from all parents and all children who are or older than 16 years old included in the study. Informed Assent was obtained from children aged 7-15 years old included in the study.

Funding: No funding was received to assist with the preparation of this manuscript.

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Introduction

Core symptoms of children with autism spectrum disorder (ASD) include delayed social communication, and restricted, repetitive behaviors and interests (American Psychiatric Association, 2013). Along with these core symptoms, research indicates that children with ASD have a 41.1% greater risk of developing obesity and physical inactivity (Kahathuduwa et al., 2019). The World Health Organization (Bull et al., 2020) advises that all children and adolescents aged 5-17 should engage in at least 60 minutes of moderate to vigorous physical activity (MVPA) daily. However, a meta-analysis (Rostami Haji Abadi et al., 2023) reported that, in comparison to typically developing children, children with ASD engage in 30 minutes less of daily MVPA. Additionally, only 42% of children and adolescents with ASD achieve the WHO's 60-minute daily MVPA recommendation (Liang et al., 2020).

Being physically active has proven to be beneficial for the core symptoms of children and youth with ASD, including social challenges and stereotypes (Howells et al., 2019; Jiang et al., 2024; Sowa & Meulenbroek, 2012), as well as motor deficiencies, skill-related fitness, muscular strength, endurance (Healy et al., 2018), and mental health (Accardo et al., 2024). Whilst there is evidence calling for the need to encourage children with ASD to engage in more physical activity (PA) , the 42% figure from Liang et al. (2020) may be an overestimation. According to Okkenhaug et al. (2024), physical activity is not a priority for many families with children with ASD due to various barriers, intrapersonal, interpersonal,

institutional, community, and public policy barriers, and physical barriers worldwide . Even when all non-intrapersonal barriers have been addressed in PA, a child without motivation cannot make a commitment to PA and will not benefit from participation in PA in the long-term. To increase the sustainability of PA programs or interventions for children with autism, it is therefore important to study motivation amongst them.

According to self-determination theory (SDT), contextual motivation drives engagement in different contexts (Vallerand, 1997). Intrinsic motivation, which involves engaging in PA for its own sake rather than for external rewards or pressures (Ryan & Deci, 2020), is crucial for improving PA levels (de Bruijn et al., 2023). Understanding the motivational dynamics towards PA in children with ASD is essential, as self-determined motivation can influence long-term participation and promote overall health (Pan et al., 2011). One mini theory of SDT is Organismic Integration Theory (OIT) (Deci & Ryan, 1985b) which identifies four types of extrinsic motivation based on internalization: external regulation (driven by rewards or the avoidance of punishment), introjected regulation (driven by self-esteem for success or by avoidance of anxiety, shame, or guilt for failure), identified regulation (driven by personally endorsing the value of an activity), and integrated regulation (fully aligned with self-concept) (Ryan & Deci, 2020). These, along with amotivation (lack of intention) and intrinsic motivation (driven by inherent interest), form a continuum of motivation.

Another mini theory of SDT- Basic Psychological Needs Theory (BPNT) (Deci & Ryan, 1985a; Ryan & Deci, 2017) suggests that fulfilling autonomy, relatedness, and competence needs enhances intrinsic motivation in various contexts, including PA, which is crucial for well-being (Fraguela-Vale et al., 2020). Autonomy is the need to feel that one has choice and willingly endorsing one's behaviour; Competence is the need to produce desired outcomes and to experience mastery; Relatedness is the need to feel connected and

belongingness with others (Deci & Ryan, 2000). The need for autonomy in OIT reflects self-determinism and the internalization of extrinsic motivation (Deci & Ryan, 1985b).To foster intrinsic (self-determined) motivation in PA, and well-being among children, the needs for autonomy, competence, and relatedness must be met within the social environment. If children's need satisfaction and their primary motivational regulations are understood, it is possible to better understand, motivationally, their PA environments and create informed interventions for them. A scoping review (Wong et al., 2024) conducted to explore motivational factors influencing participation in structured PA indicates that meeting the psychological needs of autistic children and youth supports self-determined motivation, although fulfilling these needs may differ from those of their neurotypical peers. Unsurprisingly, a very limited study, one by Pan et al. (2011), included in Wong et al. (2024) 's review, used the motivation assessment tool to measure motivation. Along with all the studies included by Wong et al. (2024), the current literature (Block et al., 2022) acknowledges the importance of motivation in interventions, but few have attempted to make this concept measurable.

To understand the contextual motivation for PA amongst children with ASD and address their unique needs, appropriate measurement tools are necessary. However, the only existing motivation assessment tool for PA in children with ASD is that of a motivation scale designed for 13- to 16-year-olds within physical education (PE) classes (Ntoumanis, 2001; Pan et al., 2011). Pan et al. (2011) uses a 7-point Likert scale to measure motivation for PE but does not explore the underlying reasons behind these choices, which is crucial given the unique characteristics of ASD. Another limitation is that the target group consists of adolescents with ASD (M age = 14.26 ± 0.89 years), who are more likely to complete the Likert scale than younger children. However, no other information regarding the children's adaptative function, mental age, or reading/writing skills was provided. There are no valid

and reliable assessments for measuring motivation in out-of-school PA contexts (e.g., daily play, exercise, sports) that cover a broader age range, including younger children (Sebire et al., 2013). PA involves people moving, acting, and performing within culturally specific spaces and contexts, and influenced by a unique array of interests, emotions, ideas, instructions, and relationships (Piggin, 2020). Since motivation for PA can differ outside of compulsory school settings (Brooke et al., 2014; To et al., 2022) and adolescents with intellectual and developmental disabilities display different PA patterns during non-school hours (Helsel et al., 2024), a tool that assesses motivation for out-of-school PA throughout childhood and adolescence is needed.

As a response to the need for an appropriate tool, specifically designed for children with ASD, the Motivation Assessment Tool for Physical Activity (MAT-PA) was recently adapted from the Motivation Assessment Tool for Physical Education (Davies et al., 2021) – a tool deemed more viable for children with ASD, and its initial content validity was confirmed by external experts (An et al., under review). It is designed for use with children with ASD, aged 6 to 17 years, in Japan, to assess their contextual motivation toward out-of-school PA. Out-of-school PA is categorized by mode, setting, and type (Eime et al., 2013), reflecting its complexity as children often participate in multiple PA modes (team sport, individual sport, organized non-competitive activities, and non-organized activities) and settings (facility-based or neighbourhood-based) for a single type of PA (Eime et al., 2016). The results of the survey from The National Sports-Life of Children and Young People (Sasakawa Sports Foundation, 2021, 2023) and the most frequently reported regular activities among adolescents with ASD from a study by Stanish et al. (2017) were used to identify the 13 types of PA —tag, rope jumping, swinging, hide and seek, soccer, badminton, basketball, table tennis, swimming, walking, running/jogging, bicycling, and exergaming—that are frequently carried out in Japan by children with ASD, as included in MAT-PA.

MAT-PA is underpinned by SDT, specifically two of its mini theories (Deci & Ryan, 1985a, 1985b; Ryan & Deci, 2017), and comprises of interactive, picture-based activities that are autism-friendly, and was designed to explore children's satisfaction of three psychological needs (autonomy, competence, and relatedness) in PA and the motivation (behavioral regulation) related to actions that drive their out-of-school PA behaviors. The newly developed MAT-PA addresses gaps in the motivation assessment tool literature (Ntoumanis, 2001; Pan et al., 2011; Sebire et al., 2013) by transitioning from a Likert-scale to pictorial, activity-based interviews, expanding the age range to include younger children, and focusing on out-of-school contexts, with expert validation involved. There is currently very limited literature (Li et al., 2023) on involving children with ASD in finalizing an assessment tool for themselves, let alone engaging them in a rigorous validation process. This study aimed to determine if the tool's target children understood the MAT-PA picture resources, instructions, items, response options, and recall period, and to improve it. Specifically, five research questions were listed to explore whether children (1) interpreted the pictures as intended, (2) understood the interview wording, (3) comprehended the activity types and response options, (4) could provide appropriate responses to different activities, and (5) could recall experiences from the past 12 months. Additionally, the study aimed to assess the appropriate age range for the daily verbal communication skills needed to use MAT-PA, to clearly determine which children with ASD can use the tool.

Methods

The tool development was conducted through multiple phases, two of which were administered concurrently, and presented within two separate studies(see Table 1). As shown in Table 1, the initial development of MAT-PA (version 0.1) and content validity testing with external experts (which led to version 0.2) have been completed (An et al., under review).

The current study provides details on the content validity testing of MAT-PA (versions 0.1, 0.2, and 0.3) with children with ASD, leading to the final version of MAT-PA.

<Table 1 Indicative Content of MAT-PA Development and Current Study Focus>

Although the MAT-PA demonstrated good content validity with external experts, adapting it for a new population and context requires assessing content validity with the target population (Mokkink et al., 2010). Content validity refers to the degree to which the content of an instrument accurately reflects the construct being measured (Mokkink et al., 2010). It encompasses three key aspects: (1) relevance: all items should be pertinent to the construct of interest within a specific population and context of use; (2) comprehensiveness: no key aspects of the construct should be missing; and (3) comprehensibility: the items should be clearly understood by the user as intended. Given that the target population consists of children, the MAT-PA was finalized by evaluating its comprehensibility (but not its relevance and comprehensiveness) with children using different versions of MAT-PA (see Table 1). Content validity was evaluated through semi-structured cognitive interviews with children with ASD, following the COnsensus-based Standards for the selection of health Measurement Instruments (COSMIN) guidelines (Terwee et al., 2018). Figure 1 shows the procedures for content validity. Each section is explained with details below. This study was approved by the university's graduate school of medicine and its ethics committee (protocol number: R4063-3).

<Fig. 1 Procedures for content validity with children>

Recruitment and eligibility criteria

Families (parents and children) were recruited by the authors, who asked school principals and special education teachers to deliver a one-page A4-size recruitment poster to parents of children attending special education classrooms in mainstream elementary, middle,

and high schools, either online or in person, in Osaka and Kyoto cities (Kansai area, known as a densely populated area in Japan). Recruitment also took place by delivering the poster to after-school day care centers and parent associations for ASD through in-person sessions and emails, with the permission and assistance of the directors or heads of the facilities in the Kansai area and Kagoshima Prefecture (rural areas in Japan). Families in the Kansai area who took part in the study at an earlier stage would recommend acquaintances who potentially met our eligibility criteria by sharing the poster. Overall, purposive sampling strategies, including maximum variation sampling, criterion-based sampling, and snowball sampling, were used to ensure that the study included children with diverse age ranges, and both genders. The recruitment lasted from November 2023 to March 2024. Parents who were interested in participating and believed their children met the eligibility criteria sent an email to the first author, who double-checked the eligibility criteria and arranged a day to explain the research purpose. On the same day that the research purpose was explained, either online or in person, and after the parents gave consent to the study, data collection with the parents began. On another day, as agreed upon by the first author and the parents, the interview was arranged at the child's school, the after-school day care, or the university where the first author is based.

Children were eligible to participate if they (1) have a medical diagnosis of ASD according to DSM-5 or DSM-IV-TR (Pervasive Developmental Disorders, Autistic Disorder, Asperger's Disorder), (2) are aged 6-17 years, (3) have no issues with expressive and receptive language in daily life, from the parent's perspective, and (4) have no other disabilities that affect activities of daily living.

Parents as participants

The first author met with each parent separately for approximately one hour to obtain signed informed consent and gather demographic information. Parents completed the Social

Responsiveness Scale, Second Edition (SRS-2) (Constantino et al., 2017) and participated in a brief interview using the Vineland Adaptive Behavior Scales, Second Edition (VABS-2) (communication domain) (Sparrow et al., 2014) to assess their child's receptive and expressive language skills. Children with limited expressive language were included to determine the minimum age equivalent for future potential participants, as "limited expressive language" was not clearly defined during the children's developmental stage and can change and improve over time. Interviews took place on separate days in a quiet room with the presence of a parent or teacher. For those unable to meet in person, assessments and documents were sent by post, and interviews were conducted online.

Measures with parents

The demographic information asked parents to provide their name, their child's name, the child's sex, date of birth, diagnosis and the year it was made, the school the child attended, and the PAs the child has typically engaged in outside of school over the past 12 months. This information served as a reference to help remind children of the activities they have been doing if they have trouble recalling them during the interview.

Social Responsiveness Scale, Second Edition (SRS-2), Japanese version (Constantino et al., 2017) is a parent written questionnaire that assesses the characteristics of ASD, such as interpersonal behavior, communication, and repetitive/addictive behaviors, for children from 2.5 years old to adults. The psychometric properties of the Japanese version have been previously validated with Japanese children (SRS-2 for school-age: internal consistency $\alpha >$ 0.918) and Japanese children with ASD (SRS-2 for school-age: internal consistency $\alpha > 0.95$; test-retest reliability 0.96) (Constantino et al., 2017). SRS-2 was used to identify the severity of social impairment in children with ASD in this study.

The Vineland Adaptive Behavior Scales, Second Edition (VABS-2), Japanese version (Sparrow et al., 2014) evaluates adaptive behavior (ability to perform daily activities necessary for personal or social fulfillment) in individuals from birth to 92 years through semi-structured interviews. It includes four primary domains and optional maladaptive behavior domains. For the VABS-2, the standardized Japanese version shows overall adequate internal consistency ($\alpha > 0.7$) and test-retest reliability (0.8) (Sparrow et al., 2014). This study focused on the receptive and expressive language subtests to assess the child's verbal communication abilities.

Children as participants

All children met with the first author in person. Informed assent was obtained from those aged 7-15, in accordance with the Graduate School Ethical Committee guidelines (in Japanese) (Ministry of Education et al., 2021). All parents and children aged 16 or older gave informed consent. Additionally, informed assent was obtained from children aged 7 to 15 who were capable of expressing their own will. Children younger than 7 years of age did not sign informed assent, but their parents provided informed consent. To help children relax, a Pokémon™ Pikachu-themed memory game with 24 cards (12 pairs) was used as an icebreaker or intermission. Prior to the interviews, the Picture Vocabulary Test-Revised (PVT-R) (Ueno et al., 2008) was administered to assess expressive vocabulary age equivalents. Children with limited expressive vocabulary were not excluded; the age equivalents from PVT-R and VABS-2 served as measurements, not eligibility criteria, to determine the acceptable age range for the MAT-PA target population.

Measures with children

The Picture Vocabulary Test- Revised (PVT-R), Japanese version (Ueno et al., 2008), is a localized version of the Peabody Picture Vocabulary Test-Revised (Dunn & Dunn,

1981) for Japanese language users (internal consistency: 0.98; test-retest reliability: 0.86). It is a developmental test that quickly assesses receptive vocabulary ability in children between the ages of 3 years and 12 years and 3 months. The assessment requires the child to select the picture that best represents the word spoken by the examiner from several options.

MAT-PA content validity with children

An interview guide, available in English and Japanese, detailed the instructions, questions, sequence. One of the child's parents or teachers was invited to join if they were willing. As shown in Figure 1, content validity with children consists of two parts: checking picture resources and implementing the MAT-PA. When testing with versions 0.1 and 0.2, children were asked about the pictures first, and then the first author conducted the MAT-PA with them. During testing with version 0.3, the first author purposely skipped the pictorial resources assessments and conducted the MAT-PA directly. Version 0.3 is the latest version, leading toward the final version. The authors noted that the pictures, which were improved from version 0.2 to version 0.3, were deemed clear enough (with simple word descriptions) for the children to comprehend.

In pictorial resources assessments, children were asked to verbalize their thoughts while responding to an open-ended question about the pictures. The interviewer explained the process, emphasizing that there were no right or wrong answers, and used prompts such as, “What is happening in this picture?” Additional prompting questions included, “Can you identify any differences between these two pictures?” If a child took longer than expected to respond, the interviewer reassured them by saying, “If you're unsure about what's happening in the picture, it's okay to say that you don't know.” Two children were administered version 0.1, ten additional children were administered version 0.2 and tested on the pictorial resource,

while the remaining children who were administered version 0.3 were not administered the pictorial resources.

The MAT-PA (different versions) was conducted with twenty children with ASD. The MAT-PA (version 0.1) was administered to two children to determine initial face validity. Expert input and feedback from these children led to the development of version 0.2. An additional ten children were then administered the MAT-PA (version 0.2), which led to the creation of version 0.3. This was followed by a different group of eight children who were administered the MAT-PA (version 0.3), resulting in the final version. The sample size for versions 0.2 and version 0.3 were determined according to the COSMIN guidelines (Terwee et al., 2018), which recommend 4-6 participants as being typically sufficient, with more than 7 participants considered "very good" for assessing the comprehensibility of a measurement instrument. Consequently, ten participants were included in version 0.2 and eight participants in version 0.3, due to participant availability and the possibility of dropout.

The entire process was recorded using high-quality audio and transcribed verbatim. Children's narrative responses were reviewed by two coders (postgraduate students) to ensure alignment with the research questions and intended constructs. For controversial items, such as questions where 50% of responses are in one direction and 50% in the opposite, the authors discussed whether to redesign the material if responses did not match the intended purpose. For the pictures, if it was feasible to enhance understanding by adding accompanying words to the pictures, the authors decided not to redraw them.

Results

Sample characteristics

Demographics and Completion Rates Twenty children aged between 6 and 17 years (mean chronological age at the first assessment = 11 years 6 months; 65% boys) were

recruited. Two children participated in the interview using MAT-PA (version 0.1). An additional ten children were interviewed using MAT-PA (version 0.2). At the final stage, eight were interviewed using MAT-PA (version 0.3). No families withdrew from the assessments or the interviews. All parents filled in the demographic information, completed the SRS-2 and received VABS-2 semi-structure interviews, and all children completed the PTV-R and attended the interview. However, attributed to short attention spans and variations in verbal abilities, two, six, and four children respectively completed the entire interview for versions 0.1, 0.2 and 0.3. Overall, twelve out of twenty children (60%) were assessed with the entire MAT-PA. The picture resources assessment was simple and came first. Despite challenges with attention spans and verbal abilities, all twelve children who were administered versions 0.1 and 0.2 gave their responses to the picture resources. However, data for child 12 was not included/analysed because the result for the SRS-2 was normal. Overall, eleven children provided responses to the pictorial resources.

Summary of SRS-2, PVT-R and VABS-2 Scores for Twenty Children The total T-score for SRS-2 ranged from 44 (normal) to higher than 90 (severe). The raw score (age equivalent) for receptive subdomain and expressive subdomain ranged from 2 years 11 months to 7 years 5 months, 2 years 7 months to 7 years 10 months respectively. The expressive vocabulary age equivalent for PVT-R ranged from 3 years to older than 12 years 3 months. The data on verbal abilities from the VABS-2 and PVT-R were compared. While the VABS-2 covers more comprehensive aspects of verbal communication skills, the expressive vocabulary age equivalent from the PVT-R has limitations and does not fully reflect the child's overall verbal abilities. Thus, the PVT-R score had not been used to determine the eligible age equivalent range for the daily verbal communication abilities required for MAT-PA's use. The characteristics of the children and their involvement in the testing with different versions are presented in Table 2.

Summary of SRS-2 and VABS-2 Scores for Twelve Children All twelve children (two using version 0.1, six using version 0.2, and four using version 0.3) completed the entire interview, and the data are summarised for them (mean chronological age at the first assessment =12 years 11 months; mean expressive age equivalent=6 years 7 months, mean receptive age equivalent= 4 years 9 months, 67 % boys). The total T-score on SRS-2 ranged from 63 (mild) to higher than 90 (severe). The raw score (age equivalent) for receptive subdomain and expressive subdomain on VABS-2 ranged from 2 years 9 months to 7 years 5 months, 5 years 4 months to 7 years 10 months respectively. It was assumed that if a child has the same receptive or expressive age as that of a 5- to 6-year-old, they should be able to use MAT-PA (Davies et al., 2021). **Expressive age** By checking the expressive age column in Table 2, most children who completed the interview have a minimum age of 5 years and 4 months. However, not all children with an expressive age older than 5 years and 4 months completed the entire interview (e.g., exceptions are child 15 and child 17). Alternatively, if the expressive age is **around 6 years**, then the child should be able to complete the entire interview**. Receptive Age** Despite having an expressive age equivalent to that of a 5- to 6-year-old, six out of twelve children (50%) had a relatively low receptive age equivalent of **around 3 years old** (e.g., child 4, child 7, child 9, child 10, child 14, and child 20) when compared to the other children in this study. Overall, the receptive age equivalent was low, but pictorial resources are believed to be helpful in improving children's understanding of the interview questions and prompts, regardless of their receptive age equivalent.

<Table 2 Characteristics of Child Participants and Their Involvement in the Study >

Description of the MAT-PA (final version)

Figure 2 provides an overview of the MAT-PA (final version). Supplementary information provides an updated description (including purpose, theoretical framework, and

constructs) of the MAT-PA and shows how the authors improved the tools from the older versions to the new one. The MAT-PA (final version) requires about 45-60 min to administer (not including the resting time and the time for PVT-R). The authors deemed the tool comprehensible, as the activities were deemed familiar and easily understood by the children, effectively addressing five research questions related to content validity (comprehensibility) about picture resources, instructions, items, response options, recall period. Thus, adhering to COSMIN guidelines, the authors concluded that the tool demonstrated good content validity. Furthermore, based on evidence from the VABS-2 (communication domains) for all twenty children, MAT-PA was deemed suitable for use with children with ASD whose verbal communication skills are equivalent to those of 3-year-olds (receptive) and 6-year-olds (expressive), though some exceptions were noted.

<Fig. 2 An overview of the MAT-PA (final version)>

Discussions

This study reports on the development and further content validity of the MAT-PA among children with ASD. While the tool's relevance and comprehensiveness have been confirmed by external experts, this manuscript focuses on its content validity, particularly its comprehensibility, as evaluated with twenty children with ASD. Their feedback led to revisions across versions 0.1, 0.2, 0.3, and the final version, demonstrating that the MAT-PA has promising content validity in terms of comprehensibility. Furthermore, the MAT-PA was determined to be suitable for use with children with ASD who have verbal communication skills comparable to those of 3-year-olds (receptive) and 6-year-olds (expressive). The discussion section is divided into two parts as follows: the first will address the overall framework and five research questions related to content validity, with a separate discussion on the appropriate age equivalent included in the limitations; the second section provides a

general discussion comparing the newly developed tool, MAT-PA, with existing motivation tools for PA.

Highlights from children's feedback and subsequent modifications

Overall theoretical framework: Children may not directly address the conceptual framework, but their responses during semi-structured interviews provided new insights, leading the authors to reconceptualize the definition of out-of-school PA, which had previously not included housework. Three children (e.g., child 2, child 7, and child 8) mentioned engaging in various housework activities outside of school, such as grocery shopping, lining up shoes, and harvesting food from gardens. A study by Klein et al. (2009) revealed that children within Los Angeles spent surprisingly little time on household work, whereas those in families with access to paid domestic help tend to be less helpful than those in families without. Additionally, children in White US middle-class families don't do enough housework (Sarmiento et al., 2024). In contrast, since there is typically no much paid domestic help but occasionally home visits for childrearing (Yamaoka et al., 2024) in Japanese households (Nagase, 2024), chores involving mostly gross motor skills, such as helping with grocery shopping and gardening, are newly added and classified as non-organized PA within MAT-PA.

The Hierarchical Model of Intrinsic and Extrinsic Motivation aims to understand individual motivation within their social contexts, showing its greatest value in these contextually situated perspectives (Vallerand, 1997), and out-of-school PA is a complex topic that encompasses a general context with many sub-contexts for different types of PAs. After discussing PA in general, the authors included additional discussions with children about the top three activities they engage in. This decision was made because interviews with children revealed that discussing specific activities is more straightforward and simpler for them. This

approach will provide detailed insights into the current PA environments, climates, and participation styles for the top three activities, and facilitate interviews with children. With this information, researchers, coaches, intervention implementers, and parents can better understand and improve participation in future activities, thereby supporting autonomy and relatedness needs.

(1) Interpretation to picture resources (modifications see Figure 2): For ***autonomy and competence***, the picture of 'exergaming' was not understood by all the children. Four children (e.g., child 1, child 6, child 8, child 9) drew “dodgeball” or “baseball” on extra sticky notes to indicate that they had been engaged in these activities over the past 12 months. Two new pictures for “dodgeball” and “baseball” were added. Modifications were made towards “exergaming”, highlighting the classic color (blue and red) of joy-con of the Nintendo Switch™ remote controls. Still, the game could be seen as either a dance exergame, a fitness exergame, or even both, depending on the child's interpretation and experience. The authors decided to retain both interpretations in the undeveloped codebook. For ***relatedness***, all children had no problems in interpreting the pictures. For ***behavioral regulations***, pictures for “introjected and external regulation (punishment)” were changed. The previous one for “introjected” did not include other children and looked the same with the one for “relatedness with adults”, which made some children feel confused. The picture for “external punishment” were altered to appear gentler; the adult no longer looks angry but still conveys the message, “I do PA because others make me.” Although it represents “punishment”, adults in Japanese cultures, where conflicts are often avoided (Fuki, 2002), typically do not get angry if children do not participate in PA. In addition, some children were confused by the previous version of the picture. They thought the adults were patting the child on the head, whereas the intended meaning was to show the adults pointing at and scolding the child. Japanese captions are recommended for all pictures (see examples in Figure 2 and 3) to provide further clarity.

<Fig. 3 Revisions to picture resources >

(2)Appropriateness of wording: In version 0.1, two children did not understand the question, "Who gets to choose to do PA?" in the ***autonomy*** activity. Combined with expert suggestions, the question was revised in version 0.2 to ask if the children are doing PA they want to do. This revision was then validated with the remaining ten children. For ***competence***, "being good at" was used in our version 0.2 because some experts mentioned the importance of defining what "doing PA well" means. However, younger children (e.g., child 1, child 4, child 7, and child 20) had difficulty distinguishing between "being good at" and "having fun"; They would rate a PA with 4 or 5 stars if they enjoyed it, even if they were not good at it. In that case, the interviewer would reinforce differences and provide specific examples (e.g., "I like running but can't run for more than ten minutes.") to help the child re-evaluate. For ***relatedness with adults***, the phrase "feeling safe and comfortable" was initially presented together in one sentence, which caused confusion. The questions were revised to two separate sentences: "feeling safe and supported" and "feeling relaxed and comfortable" to improve clarity. For ***relatedness with peers***, the phrases "feel like being with peers in PA" and "enjoying doing PA with peers" were combined into one question: "feel like doing PA with peers." "Being with peers" may be misleading, as it can imply merely being in the same place without engaging in PA together. Additionally, a new question was added to assess whether children "'feel closer to peers after doing PA with them," referring to Ntoumanis (2001)'s tool. The ability to form good relations with others, is viewed by the Japanese as a vitally important personality trait because they recognize that individual life is inextricably bound to group life (Kelly, 2001). Nakayoshi, means friendly companionship, was chosen as a translation to "feel closer" to enhance clarity. For ***behavioral regulations***, children sometimes forgot to consider out-of-school contexts and mentioned PAs in school settings. "Outside of school" was added to each item to avoid confusion. The follow-up questions for

intrinsic regulation “Why is PA fun?” was hard and abstract to answer sometimes. “What do you enjoy about being physically active outside of school?” could be used as an alternative question based on all children’s good responses. In version 0.2, the authors used the statement “I do PA because I want others to think highly of me,” but none of the six children (e.g., child 4, child 6, child 7, child 8, child 9 and child 10) who tested this version chose this regulation type. This led us to conclude that the concept of being thought highly of may be too abstract and indirect for children. The authors then revised it to “I do PA because I want others to think I am a good child” by referring to Ntoumanis (2001)’s tool and considering that “good child” is a very common term used to praise children in Japanese culture.

(3) Understanding towards activities：For ***autonomy*** activities, all children easily sorted PA cards they had been using for the past 12 months into “You” or “Others” plates. However, they struggled with follow-up questions about task difficulty, such as rule changes, due to the unstructured nature of some out-of-school PA. They found questions about space, equipment, and people easier. The final version now focuses on the top three PAs concerning these aspects. For activities like walking or running that need no equipment, the authors consider only space and people. Future codebook updates will include strategies for coding different activities. For ***competence*** activities, some children (e.g., child 1, child 9, child 14, and child 16) found it difficult to rate PAs they had never tried before. To improve this, suggestions include having the interviewer perform physical demonstrations (Barnett et al., 2016) of unfamiliar PAs and asking the child to imagine themselves attempting the activity based on Barnett et al. (2017)’s solutions to a similar question and the definition of competence as “producing desired outcomes” (the need to challenge oneself in PAs never done before). It also shows that a greater variety of competence need satisfaction components are present in this newly suggested activity, such as those represented by the item “I feel I can successfully complete difficult tasks” from the Basic Psychological Need Satisfaction and

Need Frustration Scale (Chen et al., 2015). After this, the child can rate their confidence using a 1–5-star scale. For activities related to ***relatedness***, some older children (e.g., child 6, child 8, child 9, child 10, and child 19) reported varying feelings towards different PAs. The approach was modified as follows: first, children were asked about their general feelings toward PAs, and then their feelings toward the top three PAs they had participated in were assessed. According to previous studies (Nichols et al., 2019; Obrusnikova & Cavalier, 2011; Stanish et al., 2015), children with ASD might prefer to engage in PAs independently. In our interviews, some children (e.g., child 10, child 14, child 16, child 19, and child 20) listed individual activities as their top three, which made it challenging to assess their feelings about relatedness with specific PAs. Allowing discussions of PAs both generally and specifically provided comprehensive insights. For ***behavioral regulations*** activities, all children understood that they needed to select one or multiple reasons for engaging in PA and then rank them in order of importance.

(4) Proper responses towards activities: For ***autonomy*** actives, all children had no difficulty in giving responses to "sorting, discussion". For ***competence*** activities, none of the children gave inappropriate responses rating himself/herself with 0 star or more than 5 stars. For ***relatedness*** activities, most children reported they were most similar to either child A or child B. Occasionally, their responses (e.g., child 1, child 2, child 4, child 6, child 8, and child 9) were mixed (e.g., sometimes like child A, other times like child B), which was due to varying feelings of relatedness in different PA contexts. This issue was addressed again by separating contexts into general PA and the top three PAs they had participated in. For ***behavioral regulation*** activities, all children could select and rank cards representing their reasons for engaging in PA. Notably, none of the twelve children tested with versions 0.1, 0.2, and 0.3 chose "amotivation" or "introjected regulation". One child (child 9) mentioned wanting to become stronger and healthier not to boost self-esteem or make a good

impression, but to stand up to occasional bullying. This suggests that children with ASD may be more concerned with self-esteem in PA (Arnell et al., 2018; Rivera et al., 2020) than our findings, where no one chose “introjected regulation”. They may struggle to differentiate between identified and introjected regulation, so this child's choice could reflect both. This insight is important for codebook development, and further testing with more children could provide additional information. No children chose “amotivation”, indicating that all acknowledged the importance of PAs, mainly for extrinsic motivations like losing weight and building strength for their careers. The authors assumed that this focus on extrinsic motivations stems from the group-oriented education Japanese children receive from a young age (Peak, 1989), or from the small sample size in our interviews.

(5) The best recall period: The authors discovered that the recall period of “past 12 months” was not mentioned during the interview with two children using version 0.1, which made it difficult for them to recall their memories. As a result, the recall period was added in version 0.2 and was subsequently administered to a total of ten children. For ***autonomy and relatedness***, which asked about the top three activities they had been engaged in, most children understood the “past 12 months” timeframe with additional explanation (e.g., from last January to this January or in different seasons). They would clarify when discussing activities outside this period, such as saying, “It was long ago, not even last summer.” However, for ***competence and behavioral regulation***, it was challenging to limit discussions to the “past 12 months” due to some activities being done years ago or never. MAT-PA aims to understand children’s current and recent perceptions of competence. Occasional extensions beyond the recall period are acceptable due to the memory gap between the present and the past. For example, one older child (child 8) mentioned receiving a reward for helping with farm work beyond the 12-month period. The goal of the recall period is to ensure truthful responses. If children are not fabricating stories, a 12-month period is considered appropriate,

especially for children with autism who may have additional cognitive challenges (Diehl et al., 2006).

General discussions

Compared with existing motivational assessment tools (Markland & Tobin, 2004; Sebire et al., 2013) for children regarding PA and the one for children with ASD (Pan et al., 2011), MAT-PA has five key strengths.

The first strength is its comprehensive and interactive developmental process, as well as the children's interviews. The development process involved both the authors and external experts with diverse expertise. In this study, the authors included children with ASD through purposive sampling, ensuring that content validity was assessed from multidisciplinary perspectives rather than narrow ones (Terwee et al., 2018). Content validity was assessed by interviewing children with ASD, which helps raise awareness of PA participation for children themselves. It enables children to voice their own perceptions, helps children starting to reflect on their own experiences, and to enhance children's self-awareness regarding PA participation and health. For example, one child (child 2) mentioned that he would like to resume his abandoned workout plan after the interview. Another child (child 6) was reminded of the importance of going out instead of staying at home all the time. Similar to findings from other studies focusing on first-person experiences (Harrington et al., 2014; Tesfaye et al., 2023), our findings indicate that willingness and patience in listening to children can be fundamental. This robust process indicates that future measurement studies could consider including children themselves, though challenging yet manageable, rather than focusing solely on the authorities (e.g., stakeholders, schools, and parents).

The second strength is that the presence of stakeholders amongst the research process which created a mutual learning opportunity. It is common for stakeholders to

speak on behalf of children; for example, focus groups are often organized to better support children among healthcare professionals, teachers and parents (Bolourian et al., 2022; Tawankanjanachot et al., 2024). However, it barely creates a platform to ensure the presence of all stakeholders and children in the same setting. A recent study includes young adults but not children (Lee et al., 2022). MAT-PA interviews with children allow parents, PE teachers, or homeroom teachers to be present if they are willing to, and some have noted that listening to the interviews provides valuable insights into children's PA behaviors. For example, one child (child 14) mentioned that while his mother signed him up for swimming courses, he would have preferred more options if given the chance to choose for himself. His mother didn't realize his true thoughts until MAT-PA provided a platform for him to express them. Another child (child 16)'s PE teacher, who was present during the interview, learned about the child's extracurricular activities through the talk. The teacher also showed interest in the content of MAT-PA and expressed a desire to incorporate MAT-PA elements (such as satisfaction needs) into future lessons. The third party (the first author as the interviewer and MAT-PA as the platform) serves as a turning point or coordinator in addressing inadequate stakeholder-child communication and understanding.

The third strength is its simplicity and potential benefits for a diverse target population across a broader age range. MAT-PA is the first pictorial tool featuring interactive, game-like activities that assess children's motivational perceptions of PA. It has been found to be feasible for one-on-one administration by an interviewer in a quiet, familiar location for the child, using relatively low-cost resources. Some children (e.g., child 4, child 20) expressed that they felt like they were participating in a game, rather than in a research study with the interviewer. Future studies could choose a setting familiar to the child and incorporate more game-like resources(e.g., Pokémon™ Pikachu cards were used) and activities into the research. In addition, in most studies involving children with autism

(Kangarani-Farahani et al., 2024; Kaur et al., 2024), the required minimum mental age/IQ is explicitly stated in the eligibility criteria. MAT-PA allows the children who do not meet the assumed minimum age to be participants, if the child is regarded as having no issues with expressive and receptive language in daily life from the perspective of the parents. Although it was assumed that a child with receptive or expressive skills comparable to those of a 5- to 6-year-old should be able to use MAT-PA, it was found that children with receptive skills at a 3-year-old level can also participate. Underestimation should be avoided in the future. Moreover, while MAT-PA is designed for children with ASD, it may also provide insights into the motivational dynamics of neurodiverse children. MAT-PA could potentially serve as a tool to deeply explore the motivational perceptions of typically developing children.

The fourth strength is its consideration of both general and specific aspects of out-of-school PA, providing an in-depth exploration of motivation within these complex contexts. It has been proven that children and adults with disabilities (including autism) are less active on non-school/workdays (Helsel et al., 2024). Thus, it is important to examine the out-of-school contexts where future studies and policymakers can place more emphasis on PA promotion among these populations. In MAT-PA, in addition to general out-of-PA activities, interviews with children about their top three PA activities were included, along with discussions on autonomy, competence, and relatedness with both adults and peers across a wide range of PA types. This equipped MAT-PA with a more comprehensive perspective and ensured that important details about the most frequently engaged activities were not neglected. As a result, MAT-PA is better able to address the diverse needs and personal experiences of children with ASD.

The fifth strength is its versatility for research and practice Like other assessment tools, MAT-PA can serve as a tool for motivation assessment in interventional studies, focusing on pre- and post-assessments, changes, and informing improvements for children

with ASD. Additionally, MAT-PA can be used as a guideline and checklist to help researchers, community sports coaches, after-school facility coordinators, and paediatric physical and occupational therapists modify their interaction styles and practices with children in out-of-school physical activities. To ensure MAT-PA's scalability and impact, transforming it into an app could help authorities automatically record children's responses to the interview questions and maintain better records. This would make it easier for researchers and practitioners to track historical data and compare it with updated information, rather than getting lost in verbatim transcription. Pictorial resources could also be better organized in this way.

Limitations

Six limitations were identified. **First**, difficulties arose when children were asked to recall their competence in out-of-school contexts, especially if they had only experienced PAs in school settings. In such cases, the interviewer would ask children to imagine their competence in out-of-school contexts and then rate it. MAT-PA discussions focus on self-reported PA data for children with ASD, who may have memory and cognitive challenges (Brien & Hutchins, 2024). Recall bias is a limitation that cannot be avoided, and while children may recall meaningful activities better, there's still a risk of inaccurate or incomplete reporting, especially for less frequent or salient activities. **Second**, a limitation is that the criterion "no other disabilities that affect daily life" may exclude many children with ASD. While those with comorbidities are often more sedentary (Sung et al., 2023), the goal is to develop a pictorial assessment that eventually accommodates these children. The current focus is on children without other disabilities to build a solid foundation. **Third**, MAT-PA has not yet undergone rigorous back-translation by an external translator, but this will be addressed as MAT-PA evolves into a standardized tool. **The fourth limitation** is the small

sample size for determining age equivalents for daily verbal communication with the VABS-2. A larger sample would improve precision, but due to the diversity among children with autism and complexity of skills needed for the MAT-PA, exceptions are unavoidable. In our sample of twenty, one child (child 20) did not meet the expected receptive skills for 3-year-olds or expressive skills for 6-year-olds but fully engaged in the interview. Conversely, some children (e.g., child 4, child 14, and child 16) who met the age criteria could not complete the interview. Thus, the authors encourage attempting the assessment as long as the child's age equivalents are relatively close to the minimum age requirements. **The fifth limitation** is the administration time, which takes 45 minutes to 1 hour. Although this is longer than traditional questionnaires, it is worthwhile given the depth and richness of the data provided by children. After-school services in Japan often include physical therapy (PT) or occupational therapy(OT) sessions conducted by therapists. In addition, children may attend PT or OT sessions in medical settings. **A final limitation** of this study is that it did not explicitly address regular or frequent therapy-based PAs in MAT-PA, which contribute to overall out-of-school PA levels. Further development could include a discussion of therapy-based PAs**.**

Conclusion

The MAT-PA is the first comprehensive and innovative tool designed to assess Basic Psychological Needs Satisfaction(BPNS) and motivation (behavioral regulation) in out-of-school PA among children with ASD. The MAT-PA addresses gaps in the existing literature by incorporating a participatory, pictorial and interactive approach that is inclusive for children with diverse developmental abilities. The MAT-PA has demonstrated content validity, through its iterative development process, which involved children with ASD, external experts and multidisciplinary perspectives (An et al., under review).

By addressing the motivational dynamics within out-of-school PA contexts, MAT-PA provides a potential significant resource for researchers, educators, and policymakers aiming to promote PA and health equity among children with ASD. Future work should focus on refining reliability of the tool for consideration in trial integration, exploring its applicability across diverse cultural and developmental contexts, and leveraging technology to enhance its scalability and impact.

References

Accardo, A. L., Pontes, N. M. H., & Pontes, M. C. F. (2024). Greater Physical Activity is Associated with Lower Rates of Anxiety and Depression Among Autistic and ADHD Youth: National Survey of Children's Health 2016–2020. *Journal of Autism and Developmental Disorders*, *54*(11), 4006-4018. https://doi.org/10.1007/s10803-023-06117-0

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (Vol. 5). American psychiatric association Washington, DC.

Arnell, S., Jerlinder, K., & Lundqvist, L. O. (2018). Perceptions of Physical Activity Participation Among Adolescents with Autism Spectrum Disorders: A Conceptual Model of Conditional Participation. *J Autism Dev Disord*, *48*(5), 1792-1802. https://doi.org/10.1007/s10803-017-3436-2

Barnett, L. M., Ridgers, N. D., Hesketh, K., & Salmon, J. (2017). Setting them up for lifetime activity: Play competence perceptions and physical activity in young children. *Journal of Science and Medicine in Sport*, *20*(9), 856-860. https://doi.org/10.1016/j.jsams.2017.03.003

Barnett, L. M., Vazou, S., Abbott, G., Bowe, S. J., Robinson, L. E., Ridgers, N. D., & Salmon, J. (2016). Construct validity of the pictorial scale of Perceived Movement Skill Competence. *Psychology of Sport and Exercise*, *22*, 294-302. https://doi.org/10.1016/j.psychsport.2015.09.002

Block, M., Whaley, D., Johnson, M., & Judge, J. (2022). Utilizing Self- Determination Theory to Promote Physical Activity in Individuals with Autism Spectrum Disorder. *Palaestra*, *36*(3).

Bolourian, Y., Losh, A., Hamsho, N., Eisenhower, A., & Blacher, J. (2022). General Education Teachers' Perceptions of Autism, Inclusive Practices, and Relationship Building Strategies. *Journal of Autism and Developmental Disorders*, *52*(9), 3977-3990. https://doi.org/10.1007/s10803-021-05266-4

Brien, A. R., & Hutchins, T. L. (2024). The Everyday Autobiographical Memory of Autistic Children: A Qualitative Analysis of Parent Interviews. *Topics in Language Disorders*, *44*(4), 285-303. https://doi.org/10.1097/tld.0000000000000349

Brooke, H. L., Corder, K., Atkin, A. J., & van Sluijs, E. M. F. (2014). A Systematic Literature Review with Meta-Analyses of Within- and Between-Day Differences in Objectively Measured Physical Activity in School-Aged Children. *Sports Medicine*, *44*(10), 1427-1438. https://doi.org/10.1007/s40279-014-0215-5

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., Carty, C., Chaput, J. P., Chastin, S., Chou, R., Dempsey, P. C., DiPietro, L., Ekelund, U., Firth,

J., Friedenreich, C. M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P. T., Lambert, E., Leitzmann, M., Milton, K., Ortega, F. B., Ranasinghe, C., Stamatakis, E., Tiedemann, A., Troiano, R. P., van der Ploeg, H. P., Wari, V., & Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med*, *54*(24), 1451-1462. https://doi.org/10.1136/bjsports-2020-102955

Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., Mouratidis, A., Ryan, R. M., Sheldon, K. M., Soenens, B., Van Petegem, S., & Verstuyf, J. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, *39*(2), 216-236. https://doi.org/10.1007/s11031-014-9450-1

Constantino, J. N., Gruber, C. P., & Kamio, Y. (2017). *Social responsiveness scale (SRS-2) Manual. [Japanese Social Responsiveness Scale Second Edition]*. Nihon Bunka Kagakusha.

Davies, K., Watson, P. M., Rudd, J. R., Roberts, S., Bardid, F., Knowles, Z., & Foweather, L. (2021). Development and validity of the Motivation Assessment Tool for Physical Education (MAT-PE) among young children. *Psychology of Sport & Exercise*, *54*. https://doi.org/10.1016/j.psychsport.2021.101915

de Bruijn, A. G. M., de Greeff, J. W., Temlali, T. Y., Oosterlaan, J., Smith, J., & Hartman, E. (2023). Objectively measured physical activity during primary school physical education predicts intrinsic motivation independently of academic achievement level. *British Journal of Educational Psychology*, *93*(S1), 90-112. https://doi.org/10.1111/bjep.12527

Deci, E. L., & Ryan, R. M. (1985a). Conceptualizations of Intrinsic Motivation and Self-Determination. In *Intrinsic motivation and self-determination in human behavior*. Springer, Boston, MA. https://doi.org/10.1007/978-1-4899-2271-7

Deci, E. L., & Ryan, R. M. (1985b). Toward an Organismic Integration Theory. In *Intrinsic Motivation and Self-Determination in Human Behavior*. Springer, Boston, MA. https://doi.org/10.1007/978-1-4899-2271-7_5

Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological inquiry*, *11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Diehl, J. J., Bennetto, L., & Young, E. C. (2006). Story Recall and Narrative Coherence of High-Functioning Children with Autism Spectrum Disorders. *Journal of Abnormal Child Psychology*, *34*(1), 83-98. https://doi.org/10.1007/s10802-005-9003-x

Dunn, L. M., & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test- Revised (PPVT-R)* Circle Pines, MN: American Guidance Services.

Eime, R. M., Harvey, J. T., Sawyer, N. A., Craike, M. J., Symons, C. M., & Payne, W. R. (2016). Changes in sport and physical activity participation for adolescent females: a longitudinal study. *BMC Public Health*, *16*(1), 533. https://doi.org/10.1186/s12889-016-3203-x

Eime, R. M., Harvey, J. T., Sawyer, N. A., Craike, M. J., Symons, C. M., Polman, R. C. J., & Payne, W. R. (2013). Understanding the Contexts of Adolescent Female Participation in Sport and Physical Activity. *Research Quarterly for Exercise and Sport*, *84*(2), 157-166. https://doi.org/10.1080/02701367.2013.784846

Fraguela-Vale, R., Varela-Garrote, L., Carretero-García, M., & Peralbo-Rubio, E. M. (2020). Basic Psychological Needs, Physical Self-Concept, and Physical Activity Among Adolescents: Autonomy in Focus [Original Research]. *Frontiers in psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.00491

Fuki, N. (2002). The Role of Cultural Influences in Japanese Communication: A Literature Review on Social and Situational Factors and Japanese Indirectness.

Harrington, C., Foster, M., Rodger, S., & Ashburner, J. (2014). Engaging young people with Autism Spectrum Disorder in research interviews. *British Journal of Learning Disabilities, 42*(2), 153-161. https://doi.org/10.1111/bld.12037

Healy, S., Nacario, A., Braithwaite, R. E., & Hopper, C. (2018). The effect of physical activity interventions on youth with autism spectrum disorder: A meta-analysis. *Autism Research, 11*(6), 818-833. https://doi.org/10.1002/aur.1955

Helsel, B. C., Bodde, A. E., Ptomey, L. T., Sherman, J. R., Rice, A., Donnelly, J. E., & Washburn, R. A. (2024). Physical Activity Patterns in Adolescents and Adults with Intellectual and Developmental Disabilities. *Exercise, Sport, and Movement, 2*(3), e00024. https://doi.org/10.1249/esm.0000000000000024

Howells, K., Sivaratnam, C., May, T., Lindor, E., McGillivray, J., & Rinehart, N. (2019). Efficacy of Group-Based Organised Physical Activity Participation for Social Outcomes in Children with Autism Spectrum Disorder: A Systematic Review and Meta-analysis. *Journal of Autism and Developmental Disorders, 49*(8), 3290-3308. https://doi.org/10.1007/s10803-019-04050-9

Jiang, J., Wang, G., Gu, Q., Wang, X., & Liu, J. (2024). Quantifying the efficacy of physical activity on motor skills and stereotypies in children with autism spectrum disorder: A meta-analysis of randomized controlled trials from the last decade. *Research in Autism Spectrum Disorders, 114*, 102395. https://doi.org/10.1016/j.rasd.2024.102395

Kahathuduwa, C. N., West, B. D., Blume, J., Dharavath, N., Moustaid-Moussa, N., & Mastergeorge, A. (2019). The risk of overweight and obesity in children with autism spectrum disorders: A systematic review and meta-analysis. *Obesity Reviews, 20*(12), 1679-1667. https://doi.org/10.1111/obr.12933

Kangarani-Farahani, M., Malik, M. A., & Zwicker, J. G. (2024). Motor Impairments in Children with Autism Spectrum Disorder: A Systematic Review and Meta-analysis. *Journal of Autism and Developmental Disorders, 54*(5), 1977-1997. https://doi.org/10.1007/s10803-023-05948-1

Kaur, K., Pany, S., Mohanty, S. P., Sahoo, P. K., & Rana, S. (2024). Efficacy of Cognitive Behavioral Intervention in Improving Executive Function of Children with High Functioning Autism Spectrum Disorder: A Meta-analysis. *International Journal of Special Education, 39*(1), 11-20. https://doi.org/10.52291/ijse.2024.39.2

Kelly, V. E. (2001). Peer culture and interaction: How Japanese children express their internalization of the cultural norms of group life (shudan seikatsu). In *Japanese Frames of Mind Cultural Perspectives on Human Development* (pp. 170-201). Cambridge, UK: Cambridge University Press.

Klein, W., Graesch, A. P., & Izquierdo, C. (2009). Children and Chores: A Mixed-Methods Study of Children's Household Work in Los Angeles Families. *Anthropology of Work Review, 30*(3), 98-109. https://doi.org/10.1111/j.1548-1417.2009.01030.x

Lee, G. K., Curtiss, S. L., Kuo, H. J., Chun, J., Lee, H., & Nimako, D. D. (2022). The Role of Acceptance in the Transition to Adulthood: A Multi-Informant Comparison of Practitioners, Families, and Youth with Autism. *Journal of Autism and Developmental Disorders, 52*(4), 1444-1457. https://doi.org/10.1007/s10803-021-05037-1

Li, L., Møller Christensen, B., Falkmer, M., Zhao, Y., & Huus, K. (2023). Content validity of the instrument 'Picture My Participation' for measuring participation of children with and without autism spectrum disorder in mainland China. *Scandinavian Journal of Occupational Therapy, 30*(8), 1237-1247. https://doi.org/10.1080/11038128.2023.2220911

Liang, X., Li, R., Wong, S. H. S., Sum, R. K. W., & Sit, C. H. P. (2020). Accelerometer-measured physical activity levels in children and adolescents with autism spectrum disorder: A systematic review. *Preventive Medicine Reports, 19*, 101147. https://doi.org/10.1016/j.pmedr.2020.101147

Markland, D., & Tobin, V. (2004). A Modification to the Behavioural Regulation in Exercise Questionnaire to Include an Assessment of Amotivation. *Journal of Sport and Exercise Psychology, 26*(2), 191-196. https://doi.org/10.1123/jsep.26.2.191

Ministry of Education, C., Sports, Science and Technology;, Ministry of Health, L. a. W., & Ministry of Economy, T. a. I. (2021). *人を対象とする生命科学・医学系研究に関する倫理指針ガイダンス(Guidance on Ethical Guidelines for Life Sciences and Medical Research Involving Human Subjects in Japanese)*

Mokkink, L. B., Terwee, C. B., Patrick, D. L., Alonso, J., Stratford, P. W., Knol, D. L., Bouter, L. M., & de Vet, H. C. (2010). The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. *J Clin Epidemiol, 63*(7), 737-745. https://doi.org/10.1016/j.jclinepi.2010.02.006

Nagase, N. (2024). Much to be done in Japan's family and gender equality policies. *Asia Pacific Business Review, 30*(3), 528-542. https://doi.org/10.1080/13602381.2024.2320546

Nichols, C., Block, M. E., Bishop, J. C., & McIntire, B. (2019). Physical activity in young adults with autism spectrum disorder: Parental perceptions of barriers and facilitators. *Autism, 23*(6), 1398-1407. https://doi.org/10.1177/1362361318810221

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. *British Journal of Educational Psychology, 71*(2), 225-242. https://doi.org/10.1348/000709901158497

Obrusnikova, I., & Cavalier, A. R. (2011). Perceived Barriers and Facilitators of Participation in After-School Physical Activity by Children with Autism Spectrum Disorders. *Journal of Developmental and Physical Disabilities, 23*(3), 195-211. https://doi.org/10.1007/s10882-010-9215-z

Okkenhaug, I., Jensen, M. R., & Solhaug, S. (2024). Barriers and Facilitators for Physical Activity Among Children and Youth With Autism—A Scoping Review. *Journal of Physical Activity and Health, 21*(10), 965-979. https://doi.org/10.1123/jpah.2024-0075

Pan, C.-Y., Tsai, C.-L., Chu, C.-H., & Hsieh, K.-W. (2011). Physical activity and self-determined motivation of adolescents with and without autism spectrum disorders in inclusive physical education. *Research in Autism Spectrum Disorders, 5*(2), 733-741. https://doi.org/10.1016/j.rasd.2010.08.007

Peak, L. (1989). Learning to Become Part of the Group: The Japanese Child's Transition to Preschool Life. *The Journal of Japanese Studies, 15*(1), 93-123. https://doi.org/10.2307/132409

Piggin, J. (2020). What Is Physical Activity? A Holistic Definition for Teachers, Researchers and Policy Makers [Conceptual Analysis]. *Frontiers in Sports and Active Living, 2*. https://doi.org/10.3389/fspor.2020.00072

Rivera, P., Renziehausen, J., & Garcia, J. M. (2020). Effects of an 8-Week Judo Program on Behaviors in Children with Autism Spectrum Disorder: A Mixed-Methods Approach. *Child Psychiatry & Human Development, 51*(5), 734-741. https://doi.org/10.1007/s10578-020-00994-7

Rostami Haji Abadi, M., Zheng, Y., Wharton, T., Dell, C., Vatanparast, H., Johnston, J., & Kontulainen, S. (2023). Children with Autism Spectrum Disorder Spent 30 Min Less

Daily Time in Moderate-to-Vigorous Physical Activity than Typically Developing Peers: a Meta-Analysis of Cross-sectional Data. *Review Journal of Autism and Developmental Disorders, 10*(1), 144-157. https://doi.org/10.1007/s40489-021-00262-x

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Press. https://doi.org/10.1521/978.14625/28806

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Sarmiento, M. I., Hwang, J., & Midgette, A. J. (2024). "The children don't do enough": Including children in fairness perceptions of housework. *Journal of Marriage and Family, 86*(2), 433-454. https://doi.org/10.1111/jomf.12966

Sasakawa Sports Foundation. (2021). *The 2021 SSF National Sports-Life Survey of Children and Young People Executive Summary*. https://www.ssf.or.jp/en/files/sld2021_eng_s.pdf

Sasakawa Sports Foundation. (2023). The 2023 SSF National Sports-Life Survey of Children and Young People Executive summary. https://www.ssf.or.jp/en/files/2023_SSF_National_Sports-Life_Survey.pdf

Sebire, S. J., Jago, R., Fox, K. R., Edwards, M. J., & Thompson, J. L. (2013). Testing a self-determination theory model of children's physical activity motivation: a cross-sectional study. *international journal of behavioral nutrition and physical activity, 10*(1), 111. https://doi.org/10.1186/1479-5868-10-111

Sowa, M., & Meulenbroek, R. (2012). Effects of physical exercise on Autism Spectrum Disorders: A meta-analysis. *Research in Autism Spectrum Disorders, 6*(1), 46-57. https://doi.org/10.1016/j.rasd.2011.09.001

Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2014). *Japanese version of Vineland Adaptive Behavior Scales (2nd ed.)*. Nihon Bunka Kagakusha.

Stanish, H., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. (2015). Enjoyment, Barriers, and Beliefs About Physical Activity in Adolescents With and Without Autism Spectrum Disorder. *Adapted Physical Activity Quarterly, 32*(4), 302-317. https://doi.org/10.1123/apaq.2015-0038

Stanish, H. I., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. G. (2017). Physical Activity Levels, Frequency, and Type Among Adolescents with and Without Autism Spectrum Disorder. *J Autism Dev Disord, 47*(3), 785-794. https://doi.org/10.1007/s10803-016-3001-4

Sung, M.-C., Tsai, C.-L., Chen, F.-C., Chen, C.-C., Chu, C.-H., & Pan, C.-Y. (2023). Physical Activity, Sedentary Pursuits, and their Determinants in Children with Autism Spectrum Disorders. *Journal of Developmental and Physical Disabilities, 35*(4), 683-696. https://doi.org/10.1007/s10882-022-09874-5

Tawankanjanachot, N., Truesdale, M., Orachon, P., & Kidd, L. (2024). Social skills interventions for Thai adolescents with Autism Spectrum Disorder (ASD): a qualitative study of the perceptions and experiences of Thai adolescents, their caregivers and healthcare professionals. *International Journal of Mental Health Systems, 18*(1), 1. https://doi.org/10.1186/s13033-023-00617-3

Terwee, C. B., Prinsen, C. A. C., Chiarotto, A., Westerman, M. J., Patrick, D. L., Alonso, J., Bouter, L. M., de Vet, H. C. W., & Mokkink, L. B. (2018). COSMIN methodology for evaluating the content validity of patient-reported outcome measures: a Delphi

study. *Quality of Life Research, 27*(5), 1159-1170. https://doi.org/10.1007/s11136-018-1829-0

Tesfaye, R., Courchesne, V., Mirenda, P., Mitchell, W., Nicholas, D., Singh, I., Zwaigenbaum, L., & Elsabbagh, M. (2023). Autism voices: Perspectives of the needs, challenges, and hopes for the future of autistic youth. *Autism, 27*(4), 1142-1156. https://doi.org/10.1177/13623613221132108

To, Q. G., Stanton, R., Schoeppe, S., Doering, T., & Vandelanotte, C. (2022). Differences in physical activity between weekdays and weekend days among U.S. children and adults: Cross-sectional analysis of NHANES 2011–2014 data. *Preventive Medicine Reports, 28*, 101892. https://doi.org/10.1016/j.pmedr.2022.101892

Ueno, K., Nagoshi, N., & Konuki, S. (2008). *Picture Vocabulary Test - Revised*. Nihon Bunka Kagakusha.

Vallerand, R. J. (1997). Toward A Hierarchical Model of Intrinsic and Extrinsic Motivation. In M. P. Zanna (Ed.), *Advances in Experimental Social Psychology* (Vol. 29, pp. 271-360). Academic Press. https://doi.org/10.1016/S0065-2601(08)60019-2

Wong, M. L., Girdler, S., Afsharnejad, B., Ntoumanis, N., Milbourn, B., Kebble, P., Morris, S., & Black, M. H. (2024). Motivation to participate in structured physical activity for autistic youth: A systematic scoping review. *Autism, 28*(10), 2430-2444. https://doi.org/10.1177/13623613241240603

Yamaoka, Y., Ochi, M., Fukui, M., Isumi, A., Doi, S., Fujiwara, T., & Nawa, N. (2024). Home visitors' needs and perceptions of the benefits of a home visiting program for childcare support in Japan: A qualitative study of home visitors. *Child Abuse & Neglect, 153*, 106853. https://doi.org/10.1016/j.chiabu.2024.106853

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Figure Captions

Figure 1. Procedures for content validity with children

Figure 2. An overview of the MAT-PA (final version)

Figure 3. Revisions to picture resources

Figure

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Figure 1 Procedures for content validity with children

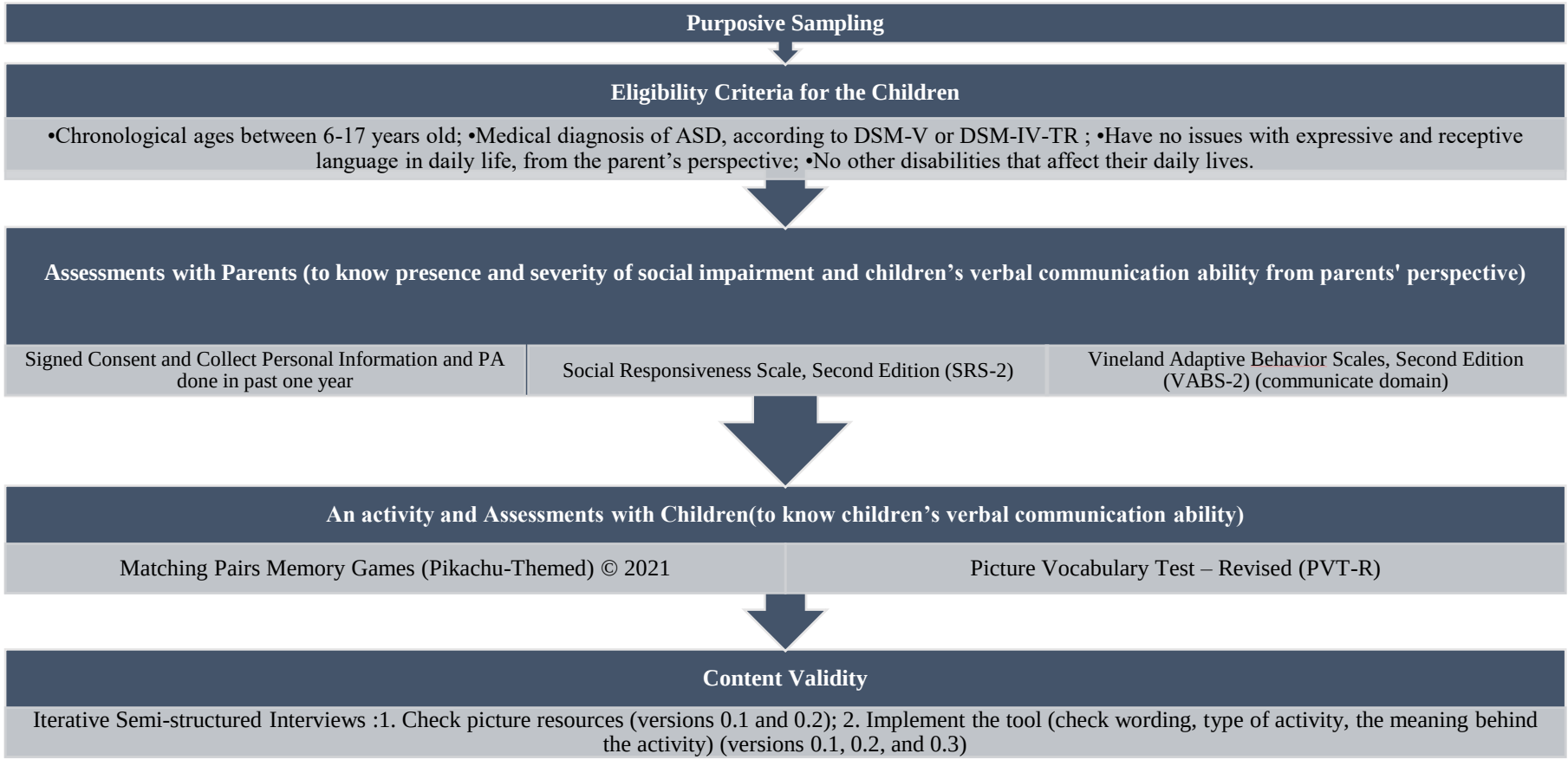

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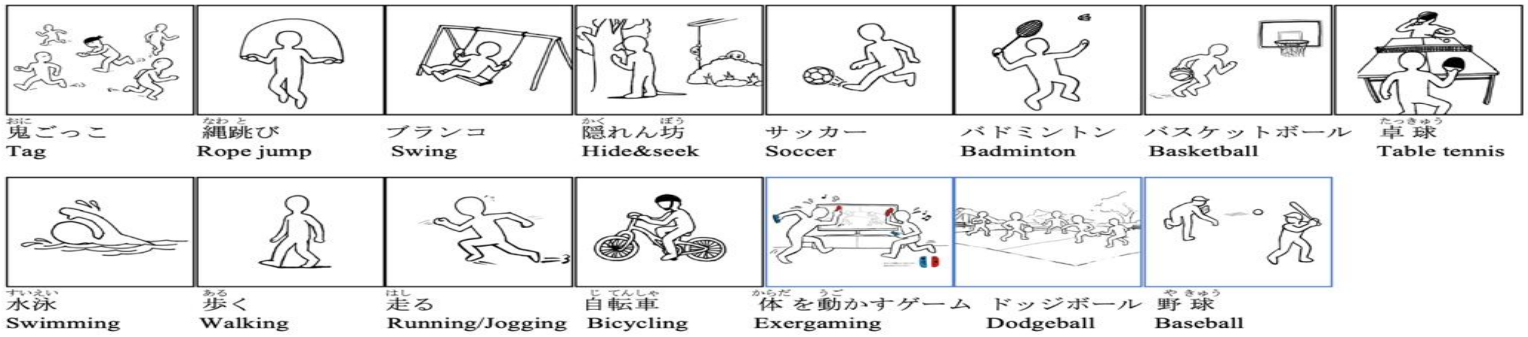
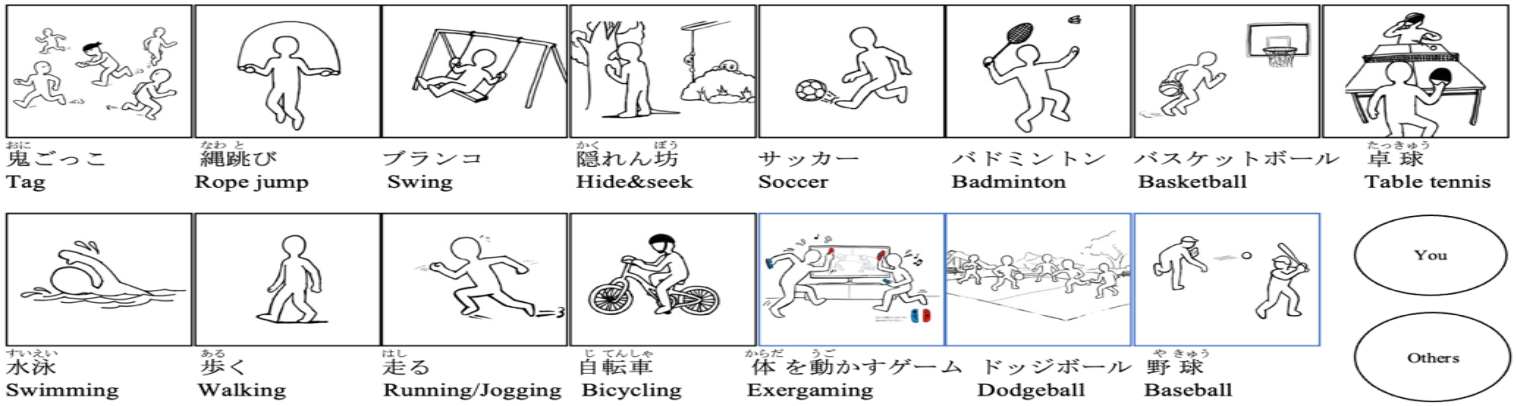
Figure 2 An overview of the MAT-PA (final version)***:All the changes made versus version 0.1 were marked bold.***

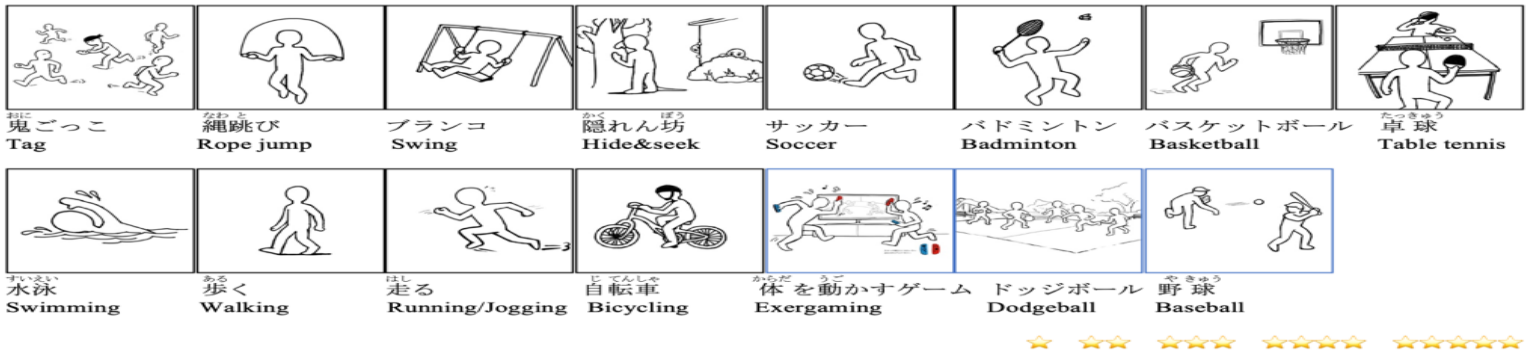
Construct &Activity Description	MAT-PA Resources (All activities completed one to one with the interviewer with the order from icebreaker to questions/stem 1 - 15.)
Icebreaker: Pair matching card game	<Pictures for Pokémon™ Pikachu> A set of PA-themed cards is laid face-up before the child. The child is asked to remember the locations of all the matching pictures. When the cards are turned over, they can flip only the matching ones. The game concludes once all the matches are found. The child has the freedom to start with fewer or more pairs of cards. The format of the game can also be flexible: the child can play independently or compete with the interviewer.
About out-of-school PAs (picking) **How to explain the 'past year' to the child: Now it would be January. The past one year means from last January to this January. In terms of seasons, it would be from last winter to this spring, summer, fall, and winter.**	
	Question/Stem(s)
	"In your daily lives, you do PAs outside of school, don't you? First, please tell me what kind of PA (including active play or exercise) you have done/been doing **within the past one year**. Are there any PAs (active play or exercise) that you do among these **15 pictures**? Please tell me by pointing out the pictures." (If the child does not do any of the PAs included in the **15 PAs** provided here, we will ask the child to draw or write about them instead.)
	"Which of the following PAs (active play or exercise) do you do most often, tell us the top 3:in order from #1 to #3? Please point out and tell me."

<table>
<tr>
<td>Autonomy Satisfaction (Sorting and discuss)

The child is presented with two plates: ‘You’ (the child’s plate) and ‘Others’ (Others’ plate). Each child is shown a series of PA they have been engaged in out-of-school contexts and asked to sort them into whether they do because they want to or they do because of other reasons.</td>
<td colspan="3"> 
</td>
</tr>
<tr>
<td colspan="2">Question/Stem(s)</td>
<td>Probe(s)</td>
</tr>
<tr>
<td colspan="3">“I'm going to ask you about your PAs you do outside of school. Here’re are some pictures of PAs (active play or exercise)”</td>
</tr>
<tr>
<td>1</td>
<td>“Among activities you have pointed out/drawn, which ones do you do because you want to, and which ones do you do because of other reasons?” (15 pictures of 15 types of PA will be shown)</td>
<td>(Show the child each picture in “you” plate one at a time and ask the question.)
“Can you tell me about a time you do this PA…?”/ “When was the last time you did this PA?”
“Where do you usually do this activity? With whom do you, do it? What tools do you use?”

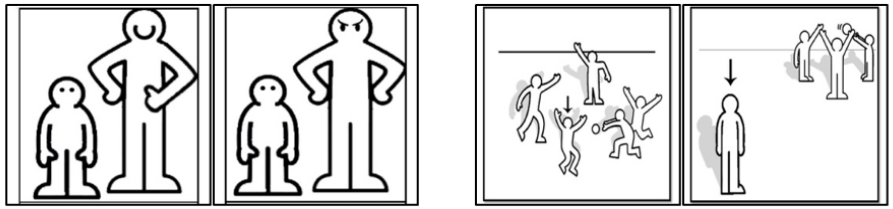
(Show the child each picture in “others” plate one at a time and ask the question.)</td>
</tr>
<tr>
<td colspan="3">Ask questions about particular PAs (top three) that the child do most often one by one.</td>
</tr>
<tr>
<td>2</td>
<td>“Can you decide the place you want to do these PAs? ”</td>
<td>“Can you always make the decision by yourself or sometimes?”</td>
</tr>
<tr>
<td>3</td>
<td>“Can you decide the people you want to play with in these PAs? ”</td>
<td>“Can you always make the decision by yourself or sometimes?”</td>
</tr>
</table>

<table>
<tr><td></td><td>4</td><td>“When participating in activities that use equipment (like balls, nets, beanbags, rackets), can you decide which equipment you want to use? ”</td><td>“Can you always make the decision by yourself or sometimes?”</td></tr>
<tr><td rowspan="5">Competence Satisfaction (Choose and discuss)

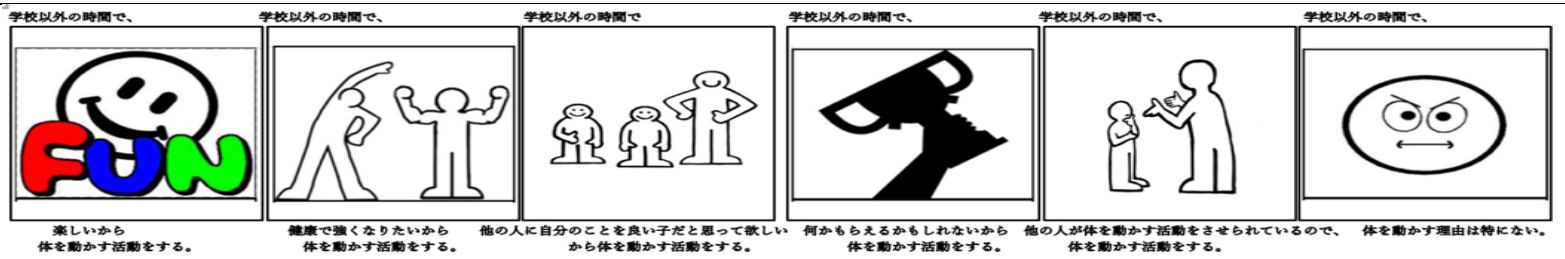
The child is presented with a series of PA and 1 to 5-star start-chart and is told by the question/stem 5.</td><td colspan="3"> 
</td></tr>
<tr><td colspan="2">Question/Stem(s)</td><td>Probe(s)</td></tr>
<tr><td colspan="3">“Here is a picture of the same 15 PAs we have showed you as before. ” For PAs that the child has never done before, the interviewer would add a physical demonstration of the PAs to enhance the understanding towards those PAs. Then, ask whether the child would like to challenge themselves and how confident the child is in completing PAs he/she has never done before.</td></tr>
<tr><td>5</td><td>“A child who is very good at this PA would get five stars. A child who is good at this PA would get four stars. A child who is neither good nor bad at this PA would get three stars. A child is not good at this PA would get two stars. A child is bad at this PA would get one star. How many stars would you give yourself for doing things in PA?”
(15 pictures of 15 types of PA will be shown one by one.
ASK: How many stars you would give yourself for tag games…etc.?)</td><td>“Why would you give yourself…star(s)?”</td></tr>
</table>

<table>
<tr><td rowspan="11">Relatedness Satisfaction (Choose and discuss)

The child is presented with two sets of cards: one set focused on the adults (family members or instructors/coaches) relationships and one set on peer (siblings and other friends) relationships.

Those adults are family members or instructors/coaches (in Japanese culture, the term teachers/staff is used) in a club or leisure center.</td><td colspan="3">  </td></tr>
<tr><td colspan="2">Question/Stem(s)</td><td>Probe(s)</td></tr>
<tr><td colspan="3">“We have two pictures here of an adult and a child. ”</td></tr>
<tr><td colspan="3">“Tell me about how you feel about adults when you engage in PAs with them. First, please think about all PAs in general, regardless of whether you are good/bad at them or not, or whether you have been doing it or not.” Then ask questions (relatedness with adults) for the particular PAs (top three) that the child do most often one by one.</td></tr>
<tr><td>6</td><td>“Child A feels safe and supported with adults in PA. Child B does not feel safe and supported with the adult in PA. Which child do you think you are most like? "</td><td>“Why do you think so?”</td></tr>
<tr><td>7</td><td>“Child A feels relaxed and comfortable with adults in PA. Child B does not feel relaxed or comfortable with the adult in PA. Which child do you think you are most like?”</td><td>“Why do you think so?”</td></tr>
<tr><td colspan="3">“We have two pictures here of other children and a child. ”</td></tr>
<tr><td colspan="3">“Tell me about how you feel about your friends or peers when you engage in PAs with them. First, please think about all PAs in general, regardless of whether you are good/bad at them, or whether you have been doing it or not.” Then, ask questions (relatedness with peers/friends) for the particular PAs (top three) that the child do most often one by one.</td></tr>
<tr><td>8</td><td>“Child C feels like doing PAs with her/his friends/peers in PA; Child D does not feel like doing PAs with her/his friends/peers in PA; Which child do you think you are most like? ”</td><td>“Why do you think so?”</td></tr>
<tr><td>9</td><td>“Child C feels that being closer to other children after doing PA with her/his peers; Child D does not feel being closer to other children after doing PA with her peers; Which child do you think you are most like? ”</td><td>“Why do you think so?”</td></tr>
</table>

<table>
<tr>
<td rowspan="6">Behavioral Regulation Type (Choose, sort and discuss)

The child is presented with all the reasons why they might take part in PA: question/stem 10-15.</td>
<td colspan="3"> 
</td>
</tr>
<tr>
<td colspan="2">Question/Stem(s)</td>
<td>Probe(s)</td>
</tr>
<tr>
<td colspan="3">“There are several reasons why we do PAs. I will show you a picture at a time. Among all pictures I have shown, what are your favourite reasons that you are doing PAs? You could choose one or more than one. Please arrange them in order(only one card is allowed in each rank). Number one means the most important reason for you; number two means the second important one and so on.”</td>
</tr>
<tr>
<td>10</td>
<td>“I do PA outside of school because PA is fun. ”</td>
<td>Intrinsic: “Why is PA outside of school fun? ”/ “What do you enjoy being physically active outside of school? ”</td>
</tr>
<tr>
<td>11</td>
<td>“I do PA outside of school because I want to be healthy and strong.”</td>
<td>Identified: “Is being healthy and strong important to you? Why? ”</td>
</tr>
<tr>
<td>12</td>
<td>“I do PA outside of school because I want others (my father and my mother or other adults in my household or other children) (usually Japanese do not have carers or helpers in the household) to think I am a good child. ”</td>
<td>Introjected: “Is it important that others to think you are a good child? Why?”
“How would you feel if they do not think you were a good child?”</td>
</tr>
<tr>
<td>13</td>
<td>“I do PA outside of school because others might get me something. ”</td>
<td>External(reward): “What rewards do you get in PA outside of school?”

“Outside of school, do you need to be good at PA to get a reward, or do you need to not mess around in PA to get a reward?”

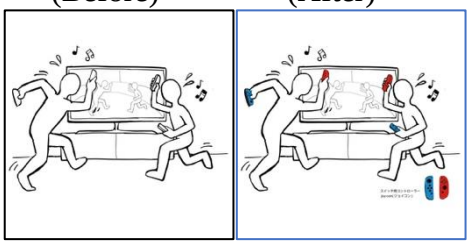
“Would you still want to do PA outside of school even if there was no reward for doing it? ”</td>
</tr>
</table>

	14	"I do PA **outside of school** because **others** make me do PA."	External(punishment): "Do you feel like other people make you do PA **outside of school** even when you don't want to?" "If nobody would make you do PA **outside of school**, would you still want to do PA? "
	15	"**I don't have any reason to do PA outside of school**."	Amotivation: "Why don't you **have any reason to do PA outside of school**? "

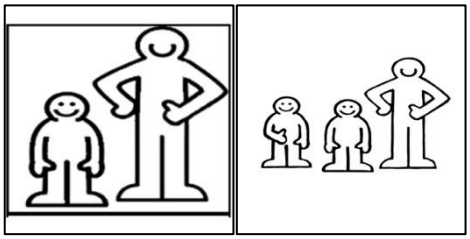
Figure 3 Revisions to picture resources

two newly added PAs: dodgeball and baseball

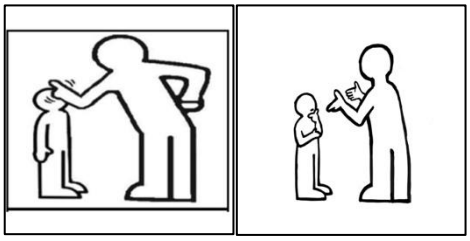
(Before) (After)



added classic color for Switch™ remote controls



behavioral regulation: “introjected regulation”



behavioral regulation: “external-punishment”

Click here to access/download;Table;Tables.docx

Table 1 Indicative Content of MAT-PA Development and Current Study Focus

<table>
<tr><td colspan="2">Another manuscript by An et al., under review –
Initial process: initial tool development and content validity with experts</td><td>Current manuscript-content validity process with children</td></tr>
<tr><td>Phase 1 (Development)</td><td>Phase 2 (Content validity)</td><td><u>Concurrent Phase of Phase 2 (Content validity)</u></td></tr>
<tr><td rowspan="2">Aim:
To adapt the MAT-PA from the MAT-PE

Findings:
Development of the MAT-PA (version 0.1)

Next step:
To ascertain initial content validity</td><td rowspan="2">Aim:
To ascertain content validity (relevance and comprehensiveness) of the MAT-PA with seven external experts

Findings:
The MAT-PA version demonstrated promising content validity

The production of the MAT-PA (version 0.2)

Next step:
To ascertain content validity from children with ASD</td><td>Aim:
To ascertain initial face validity of the MAT-PA (version 0.1) with two children

Findings:
The production of the MAT-PA(version 0.2)

Next step: the ascertain content validity from more children with ASD</td></tr>
<tr><td><u>Phase 3 (Content validity)</u>

Aim:
To ascertain content validity of the MAT-PA (version 0.2) with ten children and the content validity of the MAT-PA (version 0.3) with eight children

To produce a final version of the MAT-PA based on feedback from children with ASD.

Findings:
The production of the MAT-PA (final version)</td></tr>
</table>

Table 2 Characteristics of Child Participants and Their Involvement in the Study (○is added by the ID if the child finished the whole interview)

	Face validity/Content validity							
	Participants				SRS-2**	Vineland-2*** (receptive) Age equivalent	Vineland-2*** (expressive)Age equivalent	PVT-R**** Age equivalent
	ID	Chronological Age*	Sex	Diagnosis				
	Children 1 and 2 were tested with version 0.1, and both completed the entire interview.							
○	Child 1	9:0	Boy	ASD	88 Severe	4:6	6:11	8:10
○	Child 2	16:9	Boy	ASD	68Moderate	7:5	6:6	12:3
	Children 3 through 12 (a total of ten children) were tested with version 0.2. However, only children 4,6,7,8,9,and10 (six children) completed the entire interview.							
	Child 3	9:6	Boy	PDD	84 Severe	2:11	4:4	8:10
○	Child 4	9:3	Girl	ASD	63 Mild	3:8	5:4	8:1
	Child 5	17:2	Girl	ASD	78 Severe	5:7	4:11	9:11
○	Child 6	16:11	Girl	ASD	63 Mild	7:5	7:4	12:3
○	Child 7	10:0	Boy	ASD, ADHD	82 Severe	3:11	6:6	9:9
○	Child 8	16:11	Boy	ASD, LD	66 Moderate	7:5	8:9	12:3
○	Child 9	9:3	Boy	ASD, ADHD	73 Moderate	3:4	7:4	11:10
○	Child10	15:0	Girl	ASD	86 Severe	3:11	7:10	12:3
	Child 11	7:0	Boy	PDD	84 Severe	2:11	4:11	7:3
	Child 12	6:7	Girl	ASD, DCD	44 Normal	3:11	5:1	6:10
	Children 13 through 20 (a total of eight children) were tested with version 0.3. However, only children 14,16,19, and 20 (four children) completed the entire interview.							
	Child 13	10:1	Girl	PDD	73 Mild	3:11	5:1	9:2

○	Child14	14:8	Boy	ASD	83 Severe	3:8	5:4	11:4
	Child 15	7:10	Boy	ASD	81 Severe	3:11	5:6	7:0
○	Child16	15:2	Boy	ASD	81 Severe	4:6	5:4	10:7
	Child 17	8:10	Boy	ASD	81 Severe	2:11	5:11	6:10
	Child 18	7:9	Boy	ASD	79 Severe	3:11	2:7	3：0
○	Child19	16:5	Boy	ASD	＞＝90 Severe	4:6	7:4	12:3
○	Child 20	7:1	Girl	ASD	70 Mild	2:9	5:4	8:9
	All previous process leads to the final version of MAT-PA.							

*Child age at the first assessment. (Years and months)

**Social Responsiveness Scale Second Edition (SRS-2, Japanese version)

***Vineland Adaptive Behavior Scales Second Edition (VABS-2, Japanese version) (*only communicate domains: covering receptive subdomain and expressive subdomain)*

****Picture Vocabulary Test – Revised (PVT-R, Japanese version)

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