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Providing choice boosts immediate force production in adolescents with ADHD

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A R T I C L E I N F O

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A B S T R A C T

Children and adolescents with attention deficit hyperactivity disorder (ADHD) often struggle with motor skill performance, which can reduce their participation in sports and physical activities. This may be due to a lack of personal relevance and a sensitivity to controlling environments that reduce motivation. Since autonomy support has been shown to enhance motor performance across different motor tasks and populations, this study aimed to investigate its effects on the immediate motor performance of adolescents with ADHD during a maximum force production task. Twenty-six adolescents aged 13 to 15 (mean age = 14.1 years, 20 boys and 6 girls) participated in a within-subjects experimental design, where each performed six maximum force attempts (three attempts each hand) using a dynamometer under two conditions: choice and no-choice. In the choice condition, participants selected the order in which they used their preferred and non-preferred hands, while in the no-choice condition, they completed six attempts in an order that matched the sequence chosen by the previous participant. A 20-s rest was given between each attempt. Once participants had finished six attempts in each condition, they were asked to fill out the Intrinsic Motivation Inventory. The results showed that maximum force production, as well as self-reported interest/enjoyment, and perceived competence, were all higher in the choice condition compared to the no-choice condition. No significant differences were found in the perception of choice or pressure/tension. These findings suggest that even small opportunities for autonomy-support can improve motor performance and positively influence factors that predict intrinsic motivation specifically, interest/enjoyment and perceived competence, in adolescents with ADHD.

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1. Introduction

Attention deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized mainly by problems with attention, hyperactivity and impulsivity (Coghill et al., 2023; Wolraich et al., 2019). The symptoms are widespread, appear in more than one area, manifest themselves in different social settings (e.g., family, school) and are usually diagnosed before the age of 12 (Muskin et al., 2024). ADHD is classified into three subtypes or presentations predominantly inattentive presentation; hyperactive-impulsive presentation; combined presentation (Muskin et al., 2024). Likewise, the global prevalence of this disorder, although it depends on the country, is estimated at 7.2% (Posner et al., 2020), which is more common among boys than among girls (Faraone et al., 2021). There is a wide range of scientific evidence that indicates motor skill problems in children and adolescents with ADHD (Gillberg et al., 2004; Goulardins et al., 2017; Hyde et al., 2021;Hyde et al., 2023). These problems not only interfere with physical performance, but also compromise their self-esteem, their ability to socialize with their peers and, in the educational and/or sporting context, their adherence to and commitment to physical and/or sporting activities inside and outside school (Aranas & Leighton, 2022; Wilkes-Gillan et al., 2016). Consequently, integrating motivational components when teaching new motor skills is essential to encourage improvement in motor performance (Wulf & Lewthwaite, 2016).

In fact, motivational factors such as autonomy support have been shown to improve motor performance and learning in different tasks and populations (Wulf & Lewthwaite, 2016). Autonomy support refers to the possibilities that we, as human beings, will be in control of our actions or to make decisions related to the task we must perform and/or learn (i.e., choosing the order in which to perform a task or when to start it). In the sports context, several studies have shown that providing learners and/or athletes with autonomy, however minimal, can have significant effects on short-term motor performance as well as on motor learning itself (in the long term). In relation to motor learning, Lewthwaite et al. (2015) demonstrated that allowing participants to choose the order of execution or the color of the equipment they would use during a motor task significantly improved performance and retention, compared to conditions where decisions were imposed. Similarly, participants who were able to choose the number of shots they took at the basket showed greater technical improvement and precision compared to their peers who practiced under conditions without choice (Post et al., 2014). Furthermore, research has shown that supporting autonomy not only brings benefits for motor learning but could also benefit motor performance itself. In this regard, a study conducted by Halperin et al. (2017) showed that non-professional kickboxers, under conditions of autonomy support (they chose the order in which to perform two sets of 12 punches), obtained better results in terms of physical performance (higher levels of strength and punching speed) than under conditions without choice. Similarly, Iwatsuki et al. (2017) observed how a group of untrained participants demonstrated and maintained levels of grip strength (test performed with a dynamometer) when they performed the test under conditions of choice (they chose the order of hands, between dominant and non-dominant, to perform the maximum strength test). Taken together, these studies showed that giving participants a certain degree of autonomy, even though simple choices such as the order in which tasks are performed, can significantly improve physical performance, highlighting the importance of incorporating autonomy support strategies in sports and training contexts.

Most studies on the effectiveness of autonomy support for motor performance or learning have been conducted with athletes, untrained participants, healthy children and adolescents, and adults. However, little research has focused on individuals with conditions involving motor impairments (Chiviacowsky, Wulf, Lewthwaite, & Campos, 2012; Chiviacowsky, Wulf, Machado, & Rydberg, 2012; Zamani et al., 2015). In one study with participants with Parkinson's disease, Chiviacowsky, Wulf, Lewthwaite, and Campos (2012) found that the group with self-controlled access to a balance cane during practice learned more effectively in a delayed retention test compared to the control group. Similarly, Chiviacowsky, Wulf, Machado, and Rydberg (2012) reported that adults with Down syndrome who requested self-controlled feedback demonstrated more effective learning than the control group in a linear positioning task during the retention phase. In addition, Zamani et al. (2015) observed that children with developmental coordination disorder (DCD, aged 9–11 years) who engaged in a self-monitored overhand throwing task achieved better motor learning outcomes during retention than those who received examiner-controlled feedback. Overall, the benefits of autonomy support for motor performance and learning are not limited to healthy populations but also extend to individuals with motor impairments.

Although the benefits of autonomy support have been observed for individuals with motor impairments, little research has examined its effectiveness on motor performance and/or motor learning in children or adolescents whose difficulties stem from attention disorders such as ADHD. In this regard, Baniasadi et al. (2021) reported that adolescents with ADHD who were able to request feedback (i.e., knowledge of results) during a beanbag throwing task demonstrated significantly greater accuracy and self-efficacy in both the acquisition and retention phases than those in the control condition, indicating the benefits of self-controlled feedback on motor learning and self-efficacy. Indeed, children and adolescents with ADHD are less sensitive to positive incentives or stimuli that are not obtained immediately (Tripp & Alsop, 2001); they are more reactive (negatively) to contexts where rules or expectations are determined by other people (i.e., teachers, adults) and not by the child or adolescent themselves (Honkasilta et al., 2016). It has also been shown that ADHD children are less persistent in tasks that they do not perceive as important because they do not fit or relate to their interests or goals (Skalski et al., 2021). Moreover, since children and adolescents with ADHD are particularly sensitive to external control contexts—situations in which control or evaluation comes from outside the child, such as negative feedback, criticism, or rejection (Müller et al., 2024)—providing opportunities for choice can enhance their behavioral and emotional involvement in structured tasks or activities (Evans et al., 2016). Consequently, it has been suggested that when ADHD children are provided with the opportunity to engage in decision-making processes that pertain to their learning, such as selection of activities that align with their individualized goals, they tend to show greater commitment to the task they have to perform, which potentially is mediated by intrinsic motivation processes (Morsink et al., 2022).

Therefore, the aim of this study was to examine the effects of autonomy support on the *immediate* motor performance of a maximum force production task (e.g., hand grip strength task measured with a dynamometer) in adolescents with ADHD. It has been shown that autonomy-supportive strategies offer people the opportunity to satisfy their sense of competence, that is, to be aware to a greater or lesser extent of their ability to successfully perform a task. In this regard, providing choice conditions that support autonomy may lead to adequate levels of perceived competence, with intrinsic motivation acting as a mediating factor (Guay et al., 2001). For individuals with ADHD, who often experience heightened tension during motor tasks, providing autonomy support, especially through tasks perceived as interesting, can enhance engagement and reduce performance-related pressure. Since children and adolescents with ADHD often struggle with complex motor tasks they do not find motivating (Dekkers et al., 2017), we selected the novel handgrip strength task using a dynamometer, which is simple as it involves minimal intermuscular demands (only a few muscle groups working simultaneously in one direction) and low intramuscular coordination demands (no complex timing of motor unit activation), although intramuscular activation itself is maximal (Liao et al., 2025; Shimose et al., 2011). We hypothesized that, ADHD adolescents would improve perception of choice, perceived competence and enjoyment, and reduced pressure/tension, which subsequently produce greater force when performing the task under the choice condition (where they could choose order of hands, dominant or non-dominant hand to complete the task) compared to a no-choice condition (where the task order was yoked to that of participant in the choice condition).

2. Method

2.1. Participants

The sample consisted of 26 adolescents with ADHD (20 boys and 6 girls) aged between 13 and 15 years (mean age = 14.1 years, 20 boys and 6 girls). All 26 participants were of the combined subtype of ADHD, diagnosed following a joint assessment conducted by their schools and the health services of the XXX (XXX). Information about children was gathered during the assessment process at secondary school through observation and assessment scales that used reports from parents, teachers, and other professionals to evaluate adolescent behavior, academics, and social relationships (e.g., Conners' ADHD rating scale; Conners, 2022), while the health services conducted structured interviews with adolescents and their families, along with various neuropsychological tests, to confirm the ADHD diagnosis. All participants belonged to the same Spanish public secondary school. Our sample size was determined primarily by practical constraints (Lakens, 2013, 2022), specifically the limited access to adolescents with ADHD within a single school. Given an estimated ADHD prevalence of approximately 5.9% (Faraone et al., 2021), a school of 500 students would yield roughly 30 eligible participants, making a sample of 26 a substantial proportion of the available population.

The inclusion and exclusion criteria for this sample were as follows: schoolchildren with ADHD were included regardless of their pharmacological treatment status. Participants who scored at or above the 5th percentile on the Spanish adaptation of the d2 attention test (Seisdedos Cubero, 2012) were included, while two adolescents were excluded for scoring below the 5th percentile. Schoolchildren with neurodevelopmental difficulties such as cerebral palsy or intellectual disability (formally diagnosed based on IQ test score) were also excluded. For the recognition of participants' sex and gender, the SAGE Guidelines for Reporting Sex and Gender in Research (Heidari et al., 2016) were followed. In addition, parents and/or legal guardians of the adolescents signed an informed consent form, which provided information about the procedures involved, any potential risks or discomforts, the voluntary nature of their children's participation, confidentiality of data, and their right to withdraw at any time without any penalty. This study was approved by the Ethics Committee of XXX University of XXX, XXX (Ethics Code: 319_XX_202XXXXX_1X_SXC) on April 10, 2025. Children did not have any previous experience with the task and were not aware of the specific purpose of the study.

2.2. Apparatus and task

Partly replicating the task used in the study by Iwatsuki et al. (2017), this study used an analogue dynamometer (Grip Strength Dynamometer T.K.K. 5001 Grip-A) to measure the maximum force participants produced with both hands. To perform the task, each participant sat on a chair without armrests. The hand performing the task was held in a "handshake" position with the elbow flexed at 90°.

In addition, each participant was asked to complete the Intrinsic Motivation Inventory (IMI; Ryan et al., 1983), consisting of 22 items, assessing four dimensions on a Likert scale from 1 (not true at all) to 7 (very true): 1. Interest/enjoyment (i.e., *I enjoyed doing this activity*); 2. Perceived competence (i.e., *I think I am pretty good at this activity*); 3. Perceived Choice (i.e., *I felt I had some control over doing this activity*); 4. Pressure/tension (i.e., *I felt pressure while doing this activity*). Previous research has reported that the dimensions demonstrated very adequate internal consistency, with high Cronbach's alpha coefficients as detailed below: interest-enjoyment ($\alpha =$ 0.78), perceived competence ($\alpha = 0.80$), effort ($\alpha = 0.84$), and pressure-tension ($\alpha = 0.68$). Likewise, the overall scale showed satisfactory internal consistency with a Cronbach's alpha coefficient of $\alpha = 0.85$ (McAuley et al., 1989).

2.3. Procedure

All participants were assessed in a conventional classroom at their secondary school outside school hours. Given the well-documented heterogeneity in ADHD, including neurocognitive profiles, gender differences, symptom presentation, and comorbidities (Carucci et al., 2022; Mostert et al., 2015; Vos et al., 2022), and to minimize individual differences, this study employed a within-subjects design (Abdollahipour et al., 2017; Iwatsuki et al., 2021). Each participant first performed familiarization trials with their preferred and non-preferred hands, followed by a total of six maximum strength attempts with a dynamometer. In a counterbalanced order across participants, six attempts were performed under choice conditions and six attempts under no-choice conditions. Under the choice condition, in which participants could choose the order of their next six trials, they selected the order of hands (preferred and non-preferred), performing three attempts with the preferred hand and three attempts with the non-preferred hand in their desired sequence. Under the no-choice condition (control), participants completed three attempts with the preferred hand and three attempts with the non-preferred hand in an order determined by the principal investigator ('Now I will tell you the order in which you must perform the next six trials'). Starting with Participant 2, the imposed order matched the sequence chosen by the previous participant. For Participant 1, exceptionally in the no-choice condition, the order was determined solely by the principal investigator. A 20-s rest interval was provided between each attempt (Iwatsuki et al., 2017). Each participant completed the IMI twice: once after completing the six attempts under the choice condition and once after the six attempts under the no-choice condition. Participants did not receive any feedback (verbal or visual) about their performance outcome. The participants in this study did not receive any kind of reward at any stage of the procedure.

2.4. Data analysis

The maximum force of each trial (kg) was recorded using the values shown on the handgrip for each trial and was considered as the dependent outcome variable. No extreme outliers were found based on the criterion of 1.5 times the interquartile range from the first and third quartiles (Tukey, 1977). The data were normally distributed according to the Shapiro–Wilk test ($p > .05$). Data was analyzed with repeated-measures analysis of variance (RM ANOVA) 2 (conditions: choice and no-choice) x 6 (trials: 1–6) RM ANOVA. The assumptions of sphericity were assessed by Mauchly's test and demonstrated that the assumptions were not violated. Bonferroni adjustments were used for all pairwise post-hoc comparisons.

The assumption of normality for half of the IMI components was violated ($p < .05$). Therefore, to maintain consistency in the analysis, we primarily employed parametric tests (paired-samples *t*-tests) to examine differences between conditions. Additionally, non-parametric Wilcoxon signed-rank test results, based on mean ranks (MRank), are reported in the footnotes for comparison. The alpha level was set at 0.05 for all statistical tests.

The effect sizes were estimated using partial eta squared (ηp^2), and repeated-measures Cohen's *d* for pairwise comparisons, with 95% confidence intervals reported for all estimates to indicate precision (Cohen, 1988; Larson-Hall, 2009). For pair-wise comparisons, Cohen's *d* was calculated using the repeated-measures version, which accounts for the correlation between time points (Morris & DeShon, 2002). Data analyses were conducted using IBM SPSS Statistics Version 31.

3. Results

3.1. Maximum force

As shown in Fig. 1, results from the RM ANOVA indicated a significant main effect of condition, $F(1, 25) = 41.11$, $p < .001$, $\eta p^2 = 0.622$. Specifically, participants in the choice condition ($M = 26.88 \pm 9.51$ kg) produced significantly higher force values than in the control condition ($M = 24.64 \pm 9.09$ kg, 95% CI [1.519, 2.956]). The main effect of trials was statistically significant, $F(5, 125) = 4.03$, $p = .002$, $\eta p^2 = 0.139$. Post hoc tests revealed that participants produced significantly more force in trial 1 ($M = 26.53 \pm 9.52$ kg) compared to trial 2 ($M = 25.11 \pm 8.75$ kg, $p = .026$, $d = 0.443$, 95% CI [0.108, 2.738]). No significant differences were found between the other trials (all ps > 0.05).

The interaction between conditions and trials was not significant, $F(5, 125) = 0.19$, $p = .966$, $\eta p^2 = 0.008$.

The average difference in participants' force production comparing the choice and no-choice conditions was 2.23 ± 1.77 kg, corresponding to 9.08% relative increase in the choice condition. Additional analyses indicated that maximum force production was

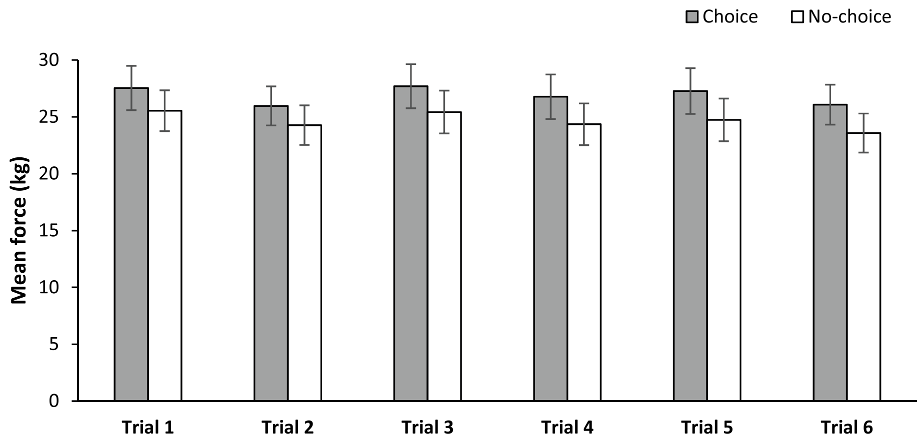

Fig. 1. Mean maximum force for choice and no-choice conditions across trials 1 through 6.
Note. Error bars represent standard error.

greater for 88.47% of participants in the choice condition compared to 11.53% in the no-choice condition. Trial-by-trail intra-individual differences in average force production between the choice and no-choice conditions are presented in Table 1.

Additional analyses showed that the maximum force was higher for the majority of participants in the choice condition across all trials, as presented in Table 2.

3.2. Intrinsic motivation inventory

The results of the paired-samples *t*-tests for the IMI revealed significant differences in participants' interest/enjoyment, with higher scores in the choice condition ($M = 4.59 \pm 0.79$) compared to the no-choice condition ($M = 4.08 \pm 0.86$), $t(25) = 5.998$, $p < .001$, $d = 1.243$, 95% CI [0.339, 0.693]. Similarly, perceived competence was significantly higher in the choice condition ($M = 4.30 \pm 0.82$) than in the no-choice condition ($M = 3.57 \pm 0.93$), $t(25) = 9.614$, $p < .001$, $d = 2.067$, 95% CI [0.574, 0.887] (Fig. 2).

In contrast, no significant differences were found in perceived choice between the choice ($M = 4.06 \pm 0.72$) and no-choice conditions ($M = 3.77 \pm 1.00$, $t(25) = 1.206$, $p = .239$, $d = 0.285$, 95% CI [−0.201, 0.770]. Likewise, there was no significant difference in pressure/tension between the choice ($M = 3.38 \pm 0.39$) and no-choice conditions ($M = 3.32 \pm 0.37$, $t(25) = 0.771$, $p = .448$, $d = 0.147$, 95% CI [−0.102, 0.225].

4. Discussion

The present study aimed to examine the effects of autonomy support on a maximum force production task in adolescents with ADHD. The results showed that, in the choice condition, adolescents with ADHD exhibited higher force values, as well as greater levels of interest, enjoyment, and perceived competence, compared to the non-choice condition. These findings are largely consistent with the study's predictions and will be discussed in detail below; however, they should be interpreted with caution, as the small sample size, while practically acceptable, remains relatively small.

Our findings corroborate the previous research on healthy individuals (Wulf & Lewthwaite, 2016) as well as individuals with conditions involving motor impairments (Chiviacowsky, Wulf, Lewthwaite, & Campos, 2012; Chiviacowsky, Wulf, Machado, & Rydberg, 2012; Zamani et al., 2015) and adolescents with ADHD (Baniasadi et al., 2021), showing that autonomy support via providing the opportunity to choose the task order produced more force in performance outcomes, particularly in adolescents with ADHD. This finding aligns with previous studies on healthy individuals, which showed that force production increased in kickboxers (Halperin et al., 2017) and university students (Iwatsuki et al., 2017) when they could choose the order of task performance. Specifically, adolescents with ADHD consistently exerted greater force in the choice condition than in the no-choice condition across all trials. This consistent pattern of force production in the choice condition is particularly important for adolescents with ADHD, as they tend to show lower persistence in tasks they perceive as unrelated to their interests or goals (Dekkers et al., 2017; Skalski et al., 2021). Consequently, it could be suggested that adolescents with ADHD are more likely to improve their performance (e.g., maximum force production) when they are given the opportunity to participate in selecting the order of task performance for their activities.

More interestingly, the findings of subjective measures assessed through the IMI subscales in adolescents with ADHD suggest that autonomy support enhanced perceived competence and interest/enjoyment (Lee & Reeve, 2013; Wulf et al., 2015). Research has indicated that in children diagnosed with ADHD, inattention and impulsivity frequently result in repeated underachievement in academic, occupational and social domains (Colomer et al., 2017; Miyadera, 2024). This phenomenon may potentially compromise self-esteem and confidence of individuals with ADHD (Barkley, 2014; Foley-Nicpon et al., 2012). In this context, the research has demonstrated that individuals who possess a degree of autonomy with regard to specific aspects of a task tend to experience an increased sense of competence, thereby engendering a more positive experience during task performance (Reeve & Tseng, 2011; Wulf et al., 2015). In addition, Mousavi and Iwatsuki (2022) have demonstrated that the presence of choice and control within the learning process serves to strengthen the self-efficacy of the learners. As such, the findings of the present study contribute to the central idea that supporting autonomy can lead to positive experiences and, concomitantly, reinforce performer enjoyment and improve perceived competence (Wulf & Lewthwaite, 2016), particularly in adolescents with ADHD. Taken together, better performance under autonomy-supportive conditions, along with increased interest/enjoyment and perceived competence, may help children and adolescents with ADHD become less sensitive to negative peer feedback, criticism, and rejection (Müller et al., 2024).

Our findings also showed that, although no significant differences were found in the perception of choice or reduced tension/

Table 1
Mean, standard deviation, percentage change, effect sizes, and confidence intervals (CI) of performance improvements in trial-by-trial intraindividual differences in force production between choice and no-choice conditions.

Trial	Average Force Difference (kg)	% Increase in Performance	Cohen's d	95% CI for Difference	
				Lower Bound	Upper Bound
1	2.00 ± 4.15	7.69 ± 15.98	0.471	0.321	3.679
2	1.69 ± 3.19	6.50 ± 12.29	0.532	0.401	2.984
3	2.26 ± 4.43	8.72 ± 17.04	0.505	0.479	4.059
4	2.42 ± 4.14	9.31 ± 15.95	0.572	0.747	4.099
5	2.53 ± 4.10	9.76 ± 15.77	0.608	0.882	4.195
6	2.50 ± 3.54	9.61 ± 13.64	0.697	1.067	3.933

Table 2
Percentage of participants exhibiting higher maximum force in the choice versus no-choice conditions across trials.

Trial	Choice Condition (%)	No-Choice Condition (%)	No Difference (%)
1	69.24	15.38	15.38
2	57.69	19.23	23.08
3	65.39	26.92	7.69
4	65.39	15.38	19.23
5	80.77	19.23	–
6	76.93	15.38	7.69

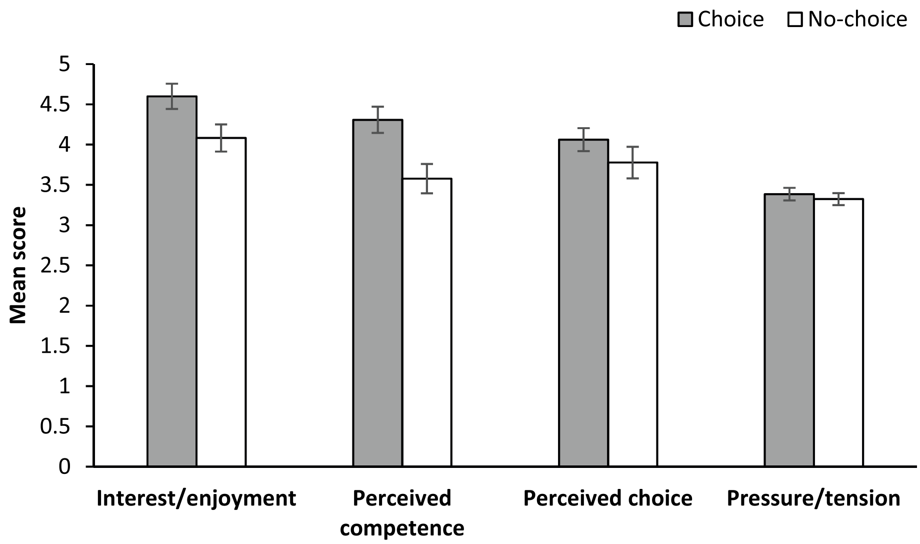

Fig. 2. Mean scores for choice and no-choice conditions on intrinsic motivation inventory subscales, including interest/enjoyment, perceived competence, perceived choice, and pressure/tension.
Note. Error bars represent standard error.

pressure between the choice and control conditions, performance could still improve even if the child does not explicitly recognize the presence of choice according to the IMI. Experiencing autonomy enhances motivation, performance, and enjoyment because it is immediate and experiential, whereas perceiving choice requires reflective awareness (Ryan & Deci, 2000)—a process that may be limited in individuals with ADHD (Butzbach et al., 2021). Consequently, we speculate that individuals with ADHD may experience increased competence and task enjoyment arising from autonomy support without explicitly recognizing autonomy as the underlying cause. In this regard, research has proposed that an individual's implicit perception of choice may help regulate motivation and improve performance outcomes (Wulf & Lewthwaite, 2016). Consequently, autonomy support likely influences performance expectations, which in turn activate implicit motivational pathways. Another possible explanation is that individuals with ADHD may need repeated practice over time to explicitly perceive choice and experience reductions in stress and tension. With respect to stress reduction, indirect evidence suggests that mindfulness training requires several weeks of practice to effectively reduce stress in individuals with ADHD (for a review, see Mitchell et al., 2014). Therefore, a more sensitive measure of stress, such as cortisol secretion as a biomarker of acute stress (Steel et al., 2021), may help detect stress levels when manipulating autonomy support. Future research should examine the long-term effects of AS interventions for ADHD, examining whether such interventions enhance the perception of choice or reduce tension or pressure over time, using more sensitive measures, including physiological indicators, to better understand the moderating factors or mechanisms underlying self-control practice effects (Grand et al., 2015).

It is important to acknowledge that the benefits of self-regulated practice and/or AS on motor performance or learning have not always been observed (e.g., Leiker et al., 2019; McKay & Ste-Marie, 2020, 2022; St. Germain et al., 2022, St. Germain et al., 2023; Yantha et al., 2022). For example, several studies with large samples ($N > 100$) have reported small effects—or even no effects—of self-controlled practice or AS compared with control conditions (e.g., Grand et al., 2015; Leiker et al., 2019; McKay & Ste-Marie, 2020, 2022), suggesting that strong conclusions should be drawn cautiously (McKay & Ste-Marie, 2022, McKay et al., 2025). Nonetheless, research using adequately powered designs (McKay & Ste-Marie, 2022, McKay et al., 2025) could provide clearer insight into how autonomy support influences motor performance and learning in ADHD, and whether task characteristics, such as fine and gross motor skills (discussed further below), affect the consistency of the patterns observed in this study in larger samples.

Overall, the results of the present study support the use of autonomy support interventions as a means of improving motor performance (Halperin et al., 2017; Iwatsuki et al., 2017, 2021), particularly in adolescents with ADHD, a population in which attention processes, motor control, and emotional regulation are frequently compromised (Hwang et al., 2015; Karalunas et al., 2020).

Specifically, the performance benefits of incorporating choice in a maximum force production task are significant, as the task primarily requires high intramuscular activation rather than intermuscular coordination (Liao et al., 2025; Shimose et al., 2011). Consequently, we suggest that practitioners working with children and adolescents with ADHD (Physical Education teachers, physiotherapists, occupational therapists, etc.) incorporate choice into their clinical interventions and/or formal classes, as this can enhance interest and participation in physical and/or sports activities and, in turn, improve their motor and conditioning performance outcomes.

5. Limitations and future research

While the findings of the present study are limited to the favorable effects of autonomy support on motor performance in a maximum force production task in children and adolescents with ADHD, future research should examine the effects of autonomy support on motor performance and long-term learning in other motor task domains, such as aiming, catching, or balance. It is important to note that our study employed a within-subject design to control for intra-individual differences in children with ADHD, including potential medication effects. Since a high percentage of adolescents with ADHD take stimulants (e.g., methylphenidate) (Schein et al., 2022), future studies, especially those using between-subject designs to investigate motor learning, should carefully monitor participants' medication status, as these medications can affect performance, control, arousal, and motivational processes.

Also, although our sample consisted of adolescents officially diagnosed with ADHD, it is important to consider comorbidities when designing and implementing autonomy-supportive interventions. In this regard, research has shown that oppositional defiant disorder (i.e., a condition involving frequent irritability, arguing with authority figures, and deliberately uncooperative or hostile behavior), and behavior disorders (i.e., conditions marked by persistent patterns of disruptive, impulsive, socially inappropriate behavior), or motor coordination disorder (Kaiser et al., 2015) are among the most common co-occurring conditions in children diagnosed with ADHD (Goulardins et al., 2024; Njardvik et al., 2025) that may interfere with the impact of the choice.

Moreover, our study followed previous protocols for rest intervals between trials (Iwatsuki et al., 2017); however, guidelines for maximal strength tasks recommend 1–2 min of rest between repeated efforts to reduce fatigue (Willardson, 2006). It has been recommended that shorter rests may limit phosphocreatine resynthesis and impair performance in maximal isometric tasks (Harris et al., 1976). Therefore, future studies should therefore allow longer recovery periods to ensure full physiological recovery.

Lastly, the present study exclusively measured outcome performance, thereby restricting our comprehension of the movement production process, encompassing the muscular activity implicated in force generation. A significant challenge faced by children with ADHD involves difficulties in controlling fine motor skills, such as handwriting and tying shoelaces (i.e., tasks that predominantly require intermuscular coordination), which may stem from challenges in sustaining attention on a given task (Barkley, 2014; Capodieci et al., 2018). However, when they are engaged or interested in a motor task, performance can improve significantly (Morsink et al., 2022). Consequently, offering choices such as selecting the color of a shoelace, or the color or shape of paper in handwriting may help children with ADHD enhance their intrinsic motivation and maintain attention toward task goals, potentially improving neuromuscular efficiency. Therefore, it would be valuable to investigate its effects not only on performance or learning outcomes (Baniasadi et al., 2021; and the current study) but also on neuromuscular activity, to determine whether autonomy support enhances children's ability to control their actions and improves neuromuscular efficiency (Iwatsuki et al., 2021).

6. Conclusions

The findings of the present study suggest that autonomy support, in the form of the provision of choices during a maximum strength task, may be associated with enhanced motor performance in children and adolescents with ADHD. More importantly, it was observed that the choice condition was accompanied by maximum strength, as well as the promotion of positive subjective experiences, including interest, enjoyment, and perceived competence, in individuals diagnosed with ADHD. In this sense, the present study provides evidence for the hypothesis that offering choices induces a motivational state conducive to motor performance, probably mediated by enhancing interest/enjoyment and self-determination, processes that are often highly compromised in children and adolescents with ADHD. Therefore, the simple inclusion of choice conditions in physical tasks may be beneficial for motor performance and subjective experience in children and/or adolescents with ADHD (Wulf & Lewthwaite, 2016), however, this interpretation should remain cautious given the limited sample size, and clearer conclusions will require future studies employing sufficiently powered designs (McKay & Ste-Marie, 2022; McKay et al., 2025).

6.1. Footnotes

The results of the Wilcoxon signed-ranks test for IMI subscales showed similar patterns between the choice and no-choice conditions: interest/enjoyment, $p < .001$; perceived competence, $p < .001$; perceived choice, $p = .369$; and pressure/tension, $p = .350$.

CRediT authorship contribution statement

Miguel Villa-de Gregorio: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Reza Abdollahipour:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Ludvík Valtr:** Writing – review & editing, Project administration, Funding acquisition, Formal analysis, Conceptualization. **Dagmar Kristín Hannesdóttir:** Writing – review & editing, Formal analysis, Data curation, Conceptualization. **Miriam Palomo-Nieto:** Writing – review & editing, Methodology, Investigation.

Irene Ramón-Otero: Writing – review & editing, Methodology, Investigation.

Consent to participate

Parents and/or legal guardians of the adolescents signed an informed consent form, which provided information about the procedures involved, any potential risks or discomforts, the voluntary nature of their children's participation, confidentiality of data, and their right to withdraw at any time without any penalty.

Ethical considerations

This study was approved by the Ethics Committee of Complutense University of Madrid, Spain (Ethics Code: 319_CE_20250410_17_SOC) on April 10, 2025. All participants provided written informed consent prior to enrolment in the study. This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

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Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Data availability

All anonymized data have been made publicly available in the Open Science Framework (OSF) repository at: https://osf.io/qup7m/overview?view_only=f4178aa8a7dd481287f7e7ec767b9053. No preregistration was conducted prior to data collection; however, all analysis procedures are transparently documented in the repository.

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