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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

The Effect of a Highly Intensive and Task Oriented Intervention Camp on Postural Control in Children with Developmental Coordination Disorder

Linde Cauwelier
Anke Schollen

Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij kinderen

PROMOTOR :

Prof. dr. Evi VERBECQUE

BEGELEIDER :

Mevrouw Silke VELGHE

2023
2024

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Preface

We want to take this moment to thank the people that have helped us these last five years.

First of all, we want to thank our promotor and supervisor Evi Verbecque and Silke Velghe for their help and feedback. They were always happy to help, quick to communicate, and were very supportive during the making of this thesis. Thanks to them, we were able to complete this master thesis.

We want to thank our teachers for the education we received at the University of Hasselt, and our internship mentors for the practical advices they have given us. We appreciate all the opportunities that were given to us.

We are also grateful for the children and parents who participated in the intervention camp.

Lastly, we want to thank our families and friends, who have been very supportive during the last five years to reach this point in our academic carreer.

We hope that you will enjoy reading this master thesis.

Cauwelier Linde and Schollen Anke

30/05/2024

Context

This master thesis was made to graduate from the master program in rehabilitation sciences and physiotherapy.

The experimental study is part of the 'gait and balance' research domain as it examines the effect of a highly intensive postural control intervention on all levels of the ICF with postural control (PC) as the primary outcome measure. The target group of this study are children with Developmental Coordination Disorder (DCD)**.** Postural control is an issue in 60-87% of these children, so this is a relevant study because there is still very little known about the parameters necessary to design an effective intervention in children with DCD. In addition, there are still very few studies available on the effect of an intervention on PC in children with DCD as well. The goal is to use the results of this study to provide insights into important parameters that must be present in a motor intervention to improve the problems experienced by children with DCD.

The study is part of an ongoing research project. It is a substudy of Silke Velghe's doctoral study titled “A highly intensive task-oriented balance training camp in children with Developmental Coordination Disorder: effects on different levels of child-functioning and parent perspectives”. This is a clinical trial with a pre-post interventional test design, with a triple non-training baseline and follow-up. There are five test moments in total; one baseline assessment, six months prior to the intervention (T1), one testing three-months prior to the intervention (T2), a pre- (T3) and post-interventional assessment (T4), and one follow-up assessment (T5). The research is conducted at Sint-Gerardus, a school in Diepenbeek for children with physical disabilities, during school vacations. Children between 6 and 12 years old, with (probable) DCD, were recruited through informational flyers, social media, private practices, the network of the research team, and VZW Dyspraxis. All participants were screened, using the DSM-5 diagnostic criteria for DCD (APA, 2013).The substudy focuses on the quantitative data concerning the results surrounding PC, gross motor skills, self-perceived competence, and individual goals. Each camp consists of six days of therapy, with a total therapy time of 40 hours, which makes the intervention highly intensive. This high number of therapy hours is already used within the cerebral palsy population, but not yet within the DCD population, where maybe similar effects can be found. During the camp, a 1:1 participant-therapist ratio is used, to provide individual adjustments concerning the skill level of the children, for each activity during the group- and individual sessions.

The 1:1 ratio is feasible because of the involvement of the first year master students of the faculty of rehabilitation sciences and physiotherapy. The interventional activities during the camp were organised and guided by first year master students of the rehabilitation sciences faculty. The camp was supervised by PhD students, professors and teachers of Hasselt University. Furthermore, the tests were also partially administered by students, giving them the opportunity to get assessment-experiences. These assessments were also recorded on video. We as students of this master thesis assisted in scoring the tests through these videos.

This substudy uses the data of T3, T4 and T5, to investigate the effect of a highly intensive interventional camp on the PC of children with DCD. The research question for this thesis was discussed with the promotor and supervisor Evi Verbeque and Silke Velghe. We assisted with the data acquisition during testing moments. During the scientific internship period of the first master year, the writing out of the script and activities took place. We also participated in at least one of the interventional camps as one of the therapists to coach and guide one of the participants. During these camps, we assisted and organised the activities. During the second master year, the scoring of all videos, taken during the testing moments, data digitisation, and the writing of the thesis itself took place. We were free to plan the overall timeline of our thesis, and to divide and organise all the tasks concerning this study. Our promotor and supervisor gave us advice concerning the scoring of the tests and the contents of our thesis.

This is a duo master thesis. The cooperation went very smoothly. The tasks were equally divided, and we complemented each other well. Since the data for this study was taken from two camps, the data digitisation and scoring of the tests was easily equally divided. Anke wrote out a lot as she is very strong with the English language and Linde completed the text where necessary and made suggestions on the wording of the text that was already written. For statistical purposes, we each wrote out two of the four outcome measures in the results. For questions or concerns about the content of the thesis, our promotor and supervisor were very helpful. Communication between the research team and between the master students went smoothly.

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Abstract

Background: Developmental Coordination Disorder (DCD) is characterized by poor Postural Control (PC) and coordination of movement, affecting activities of daily living and participation. Despite the high prevalence of PC deficits in children with DCD (60-87%), little is known about how to train it effectively.

Objectives: The aim of this study was to determine the effects of a highly intensive, task-oriented intervention program on PC, self-perceived competence, gross motor skills, and individual goals in children with DCD.

Methods: Twenty children with DCD (age 6-12) participated in a six-day highly intensive task-oriented intervention, comprising of group- and individual sessions, with a 1:1 participant-therapist ratio. The effect was assessed with the Balance Evaluation System Test for children (Kids-BESTest); the Test of Gross Motor Development, 3rd edition (TGMD-3); the 'Competentie Belevings Schaal voor Kinderen' (CBSK) or Pictorial Scale of Perceived Competence and Social Acceptance (PSPCSA); and the Canadian Occupational Performance Measure (COPM). All data was analysed using JMP Pro 17.

Results: The time effect was significant on the total Kids-BESTest scores ($p=0.0199$), self-perceived peer acceptance ($p=0.028$) and cognition ($p=0.037$), and the performance and satisfaction scores of COPM of the three goals ($p<0.0001$). Total scores on the TGMD-3 ($p=0.139$) and self-perceived physical competence ($p=0.781$) did not change significantly.

Conclusion: A highly intensive task-oriented intervention is an effective method to improve PC and individual goals in children with DCD. Additionally, a positive effect on self-perceived cognition and peer acceptance, can be achieved.

Keywords: Postural control, developmental coordination disorder, highly intensive intervention, neurodevelopmental disorder

Introduction

Developmental Coordination Disorder (DCD) is a complex neurodevelopmental disorder that affects approximately 5-6% of school-aged children resulting in clumsy motor behaviour, and poor motor control, postural control (PC), and coordination of movement. Additionally, DCD is often associated with comorbidities such as Attention Deficit and Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD) (Blank et al., 2019). These children execute coordinated motor skills below the expected level for their age (APA, 2013), affecting activities of daily living (ADL) and can have consequences for their self-perceived competence (Blank et al., 2019). The experienced problems reach all aspects of the ICF framework (Ferguson et al., 2014).

There is a lack of PC in 60-87% of children with DCD (Verbecque et al., 2021). Even though PC within DCD is not researched specifically, there is a recurring trend to support that PC problems are a key feature in DCD and that they should be treated with a task-oriented approach (Lust et al., 2022).

Different underlying mechanisms enable a person to keep their balance within a skill. Horak et al. (2006) describes these mechanisms within a framework of PC. The framework consists of six domains, which are described in Appendix 1. There is still uncertainty about which domains of this framework are affected in children with DCD and the specific cause of impaired PC in children with DCD. However, Verbecque et al. (2021) showed that an impaired sensory orientation and anticipatory control in children with DCD could explain the lack of PC, but they suggest more research on this topic due to conflicting results in other domains.

Even though there are many studies that have examined the effect of specific types of interventions on motor skills in children with DCD (Preston et al., 2017; Smits-Engelsman et al., 2018; Yu et al., 2018), there lacks a clear protocol to improve PC in children with DCD (Velghe et al., 2024). Less than 50% of the protocols used in these studies intend to train PC. Not all seven systems of the framework are targeted, and the protocols lack the goal-oriented needs and context-specificity which is necessary for optimal training (Velghe, Unpublished). Nevertheless, there are a number of factors, used in the previous studies, that are important to achieve positive effects for children with DCD. Both Zwicker et al. (2015) and Krajenbrink et al. (2022) suggest the possible effectiveness of highly intensive interventions (HII) in children with DCD, taking into account that there was no focus on PC in these studies. In a HII, to achieve motor learning, the time on task is important. At least 70% of session time should be spent on the task itself, with 30% going to rest, feedback and instructions (van Empelen, 2016). The number of repetitions during the session, and the number of sessions during the intervention period should be high enough to allow motor learning. For children with cerebral palsy (CP), there is no consensus on the total duration and the number of repetitions yet, however, HII in this population is defined as at least 30 hours, and a minimum of three therapy sessions per week (Jackman et al., 2020).

Another important factor within therapy used in Krajenbrink's (2022) study is task-specific training. This type of training belongs within the task-oriented approach, where Cognitive Orientation to daily Occupational Performance (CO-OP) and Neuromotor Task Training (NTT) also have their place. NTT was developed for children with DCD, where a specific skill is broken down into different component parts, which makes it possible to focus on the main problems in the task. NTT considers the learning stage of the child (cognitive, associative, autonomous) to make the choice between implicit and explicit instructions. CO-OP focuses on the goals of the child, by improving their knowledge of the task and helping them develop cognitive strategies to improve their goal (Blank et al., 2012).

To conclude, there are not yet enough evidence-based protocols to improve PC in children with DCD, and there is a lack of a clear framework for treatment. The protocols are often not task-specific and not all PC domains are included.

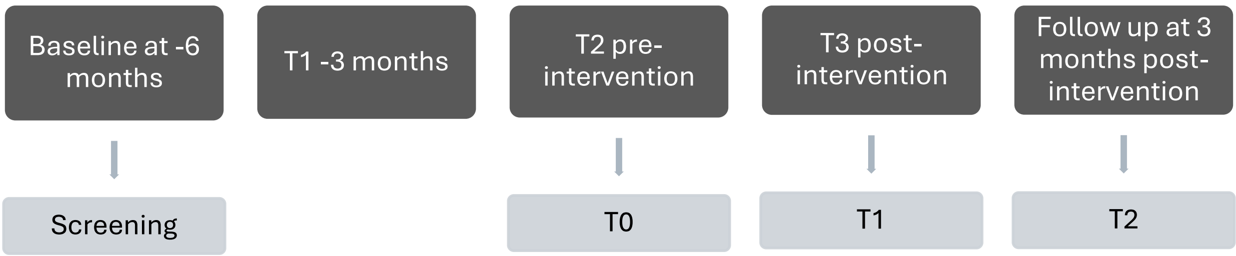
The primary aim of this interventional study is to determine the short- (after intervention) and medium-term (three month) effects of a highly intensive task-oriented intervention, which focuses on the framework of PC, embedded in motor skill activities, on PC in children with DCD measured with the Kids-BESTest. We hypothesise that a highly intensive, task-oriented intervention will improve PC performance in children with DCD. In addition, we would also like to examine the effect of this intervention on self-perceived competence (measured with the CBSK or the PSPCSA), motor skills (measured with the TGMD-3) and the children's individual goals (measured with the COPM). We assume that this intervention will also have a positive effect on the latter. Because we expect that specific groups of children will benefit more from this intervention, covariates are used in this study (Appendix 5).

Methods

Study Design

This study is part of a larger study comprising of a triple baseline pre-post design with follow-up. Here, we report only the pre-post part of the study with follow-up . Participants were assessed immediately before the start of the intervention (T0, pre-intervention), immediately after the intervention (T1, post-intervention), and three months after the intervention camp (T2, follow-up) (Figure 1).

Figure 1
Flowchart of Assessments of the Clinical Trial



Note. T = Test moment; dark grey = main study; light grey = thesis study; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Participants

The population of interest were children aged between 6 and 12 years at the moment of the start of the camp. Children with a diagnosis of DCD, who met the DSM-5 criteria (Table 1), or with probable DCD (when children met criteria A, B, and C of the DSM-5 criteria) were qualified for this interventional study. The children were included if they scored below the 50th percentile for the balance subscale of the MABC-2 and below 80% on the Kids-BESTest total score. Children with serious behavioural problems, who could not follow instructions adequately, were excluded. Because our study is limited to the pre-post intervention measurements with follow-up and does not include the triple baseline measures, there will be some children who already have a score higher than 80% at T0, but at the test moment 6 months before camp (which belongs to the full doctoral study) they did score below 80% and therefore they were included.

Table 1
*Description of DSM-5 criteria for Developmental Coordination Disorder (DCD)**

Criterium	Description
A	The acquisition and execution of coordinated motor skills is substantially below that expected given the individual's chronological age and opportunity for skill learning and use. Difficulties are manifested as clumsiness (e.g., dropping or bumping into objects) as well as slowness and inaccuracy of performance of motor skills (e.g., catching an object, using scissors or cutlery, handwriting, riding a bike, or participating in sports).
B	The motor skills deficit in Criterion A significantly and persistently interferes with activities of daily living appropriate to chronological age (e.g., self-care and self-maintenance) and impacts academic/school productivity, prevocational and vocational activities, leisure, and play.
C	Onset of symptoms is in the early developmental period.
D	The motor skills deficits are not better explained by intellectual disability (intellectual developmental disorder) or visual impairment and are not attributable to a neurological condition affecting movement (e.g., cerebral palsy, muscular dystrophy, or degenerative disorder).

*As described in the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (2013).

Procedure/recruitment

The participants were recruited via social media, flyers, websites, the network of the research team, VZW Dyspraxis, and private practices located in Diepenbeek, Limburg. Parents of children with DCD, who met the inclusion criteria, were contacted. An informed consent, approved by the ethical committee, was signed by the parents. An age-appropriate assent form was signed by the children. This study was approved by the committee for Medical Ethics of B115202200000.

Tests and Measures

Screening measures

MABC-2

The Movement Assessment Battery for Children, second edition (MABC-2), was used to screen the children for inclusion (percentile ≤16). The MABC-2 is a discriminative and evaluative test. There are three different age bands (ranging from 3 to 16 years), comprising eight age-specific tasks each, covering three domains: aiming and catching, manual dexterity, and balance. The scoring uses a traffic light system where green resembles a normal development, orange resembles an at risk development (≤16%), and red means a definite motor impairment (≤5%). The test has good to excellent test-retest reliability, good interrater reliability, the test's structure has been confirmed in many different countries and the total score distinguishes children with DCD from their TD peers (Griffiths et al., 2018). Sensitivity and specificity have not been established yet (van Empelen, 2016).

DCD-Q

The Developmental Coordination Disorder Questionnaire screens for children’s motor problems during their ADL. It is a 15-item questionnaire, using a 5-point rating scale (1: not at all like your child; 5: extremely like your child). The questionnaire was filled out by the parents. The total sum of the scores is calculated, with a minimum of 15 and a maximum of 75. The DCD-Q is a criterium-scored test for children aged 5 to 15 years old and it has different cutoff values for suspected DCD depending on age. For children between 5 and 7 years and 11 months, the cutoff values are 0-46, for children between 8 and 9 years and 11 months 0-55 and for children between 10 years and 15 years and 6 months the cutoff values are 0-57. Internal consistency, test-retest reliability and interrater reliability are good. There is a moderate correlation between the parents' impression of their child's motor competence and the prestation during the MABC-2 (van Empelen, 2016).

Outcome measures

Kids-BESTest

The Balance Evaluation System for Children is a clinical balance assessment tool that consists of 36 items, grouped into 6 systems (Table 2). It can be assessed in children aged 8 to 17 years. The reliability of the kids-BESTest is excellent (all ICC’s 0.96-0.99) (Dewar et al., 2019) and it has also a very good validity (Horak et al., 2009). An age-specific version was developed for children between 5 to 14 years old.

Table 2
*Overview of Kids-BESTest Domains**

Domain	Domain description	Items
I	Biomechanical constraints	Base of support, center of mass alignment, ankle strength, hip/trunk lateral strength, sit on floor and stand up
II	Limits of stability and verticality	Lean (L+R), verticality (L+R), forward functional reach, lateral functional reach (L+R)
III	Transitions and anticipatory postural adjustments	Sit to stand, rise to toes, stand on one leg (L+R), alternate stair touching, standing arm raise
IV	Reactive postural responses	In place response forward & backward, compensatory stepping correction forward, backward and lateral (L+R)
V	Sensory orientation	Modified CTSIB (standing on ground eyes open and eyes closed, standing on foam eyes open and eyes closed), incline eyes closed
VI	Stability in gait	Level walking, change in gait speed, walk with horizontal head turns, pivot turns, step over obstacle, the Timed up and Go test with(out) a dual task

*Adopted from Protocol Paper (Velghe et al., 2024)
Note. L: left; R: right; CTSIB: Clinical Test for Sensory Interaction in Balance.

TGMD-3

The Test of Gross Motor Development, 3rd edition is a renewed version of the TGMD-2 that measures the quality of performance of gross motor skills, scored by three or four criteria, in children from 3-10 years. It consists of 12 fundamental gross motor skills that are divided into two domains: locomotor skills (LM) and ball skills (BS) (Table 3). The raw scores of the different skills can be converted into standard scores and a percentile rank (van Empelen, 2016). The TGMD-3 has excellent internal consistency, good test-retest reliability and acceptable construct validity (Webster & Ulrich, 2017).

Table 3
Overview of TGMD-3 Domains

Domain	Items
Locomotor skills	• Run • Gallop • Hop • Skip • Horizontal jump • Slide
Ball skills	• Two-hand strike of a stationary ball • One-hand strike of self-bounced ball • One-hand stationary dribble • Two-hand catch • Kick a stationary ball • Overhand throw • Underhand throw

CBSK/PSPCSA

The 'Competentie Belevings Schaal voor Kinderen' is a questionnaire for children from 8 to 12 years that examines how children assess themselves in terms of functioning and self-esteem. The questionnaire consists of 36 items across six subscales: school skills, social acceptance, sporting skills, physical appearance, behavioural attitude, and self-esteem. The four answer options indicate the extent to which the child thinks the statement suits him/her. The test-retest reliability shows a correlation between 0.68-0.86 (van Empelen, 2016).

The Pictorial Scale of Perceived Competence and Social Acceptance measures the same as the CBSK, but this is a scale for children aged 6 to 7 years, which is why an image is used instead of a statement. It is a self-report instrument that consists of 4 domains: cognitive competence, physical competence, peer acceptance and maternal acceptance. Each domain has 6 items that are scored on a 4-point ordinal scale. Higher subscale scores indicate higher competence. This test has good reliability (Harter & Pike, 1984).

In this study, the two questionnaires are combined in one data set. The PSPCSA data was converted to be compatible with the data of the CBSK, to be able to analyse the self perceived competence of the whole group of participants. Only the subscales cognition, physical competence and peer acceptance were analysed in this study, since these are the domains covered in both tests.

COPM

The Canadian Occupational Performance Measure is a semi-structured interview and aims to evaluate the treatment result. Parents and/or children are asked to identify three daily activities they encounter difficulties with and rate the importance and satisfaction of these activities on a scale from 1 (lowest score) to 10 (highest score). Based on these scores, three treatment goals are identified and rated for performance and satisfaction. These goals are determined based on importance and are ranked from goal 1 (the primary and most important goal) to goal 3 (the least important of the 3). The final COPM-score is the sum of all the performance- and satisfaction scores divided by the amount of activities that were chosen as treatment goals. A 2 point difference in the score is used to assume a clinical relevant change. (van Empelen, 2016). The COPM has an excellent reliability and it's a valid measure of occupational performance (Carswell et al., 2004).

Intervention

The six-day intervention consisted of task-oriented, fun, motor activities, with success experiences as an important factor. During the intervention, the goal was to achieve a high time on task (at least 70% of therapy time), i.e. a greater power law of practice; more repetitions will enhance the performance. Enough repetitions are necessary to accomplish motor learning (van Empelen, 2016).

Each set of functional activities belonged to a specific category. The purpose of these categories was to be sure that every domain of the conceptual framework was covered throughout the intervention. To dress up the camp, a general theme was used. The theme 'circus' was chosen because circus-themed activities are fun activities with the implementation of many aspects of the conceptual framework. Appendix 2 provides an overview of these categories and a few examples of activities that were executed during the camp.

The total therapy time was 40 hours. Every intervention day followed a similar schedule (Appendix 3), where intervention sessions and active breaks alternated with each other. The lunch break specifically was a one-hour passive break, where the children were not allowed to be active.

Each participant had an individual therapist who could modify the activities to meet the child's needs and abilities when necessary. The 1:1 ratio made it possible to encourage and guide each child individually. All therapists were physiotherapy students at Hasselt University. The therapists, which were assigned one child during the intervention camp, underwent specific training in advance. This training consisted of theoretical and practical aspects of how to give good instructions and feedback to a child with DCD. It was important that each therapist knew each activity very well, so an overview of the activities was given in a script, and the practice of difficult activities was part of the training.

The intervention consisted mainly of group sessions (6 and 12 children) and one individual session per day. These individual sessions focused on the individual goals of the child. Before the camp started, the children had formulated three functional goals, using the COPM, for improving motor skills, e.g. cycling, running faster, learning to do a cartwheel, skating, rope-skipping, etc. It was important that each of the three goals had been practised equally by the end of the camp.

It was important that sufficient emphasis was placed on the principles of motor learning. Both implicit and explicit learning was essential. Implicit learning is defined as learning without awareness and with no or minimal increase in verbal knowledge. Explicit learning is defined as learning which generates verbal knowledge of movement performance, involves cognitive stages within the learning process and is dependent on working memory involvement (Kleynen et al., 2014). The instructions and feedback that are given to the child, while learning motor skills, depend on the stage of the motor learning process the child is in, environmental factors and other child factors. While explicit instructions and feedback with internal focus (e.g. 'bend your knees more') are very important during the cognitive phase, implicit instructions, and feedback with external focus (e.g. 'try to throw the ball through the basketball ring') are more important during the autonomous stage (van Empelen, 2016).

Throughout the camp implicit instructions and feedback were preferred, but the individual coaching made it possible to change it to explicit learning when it was necessary, according to the learning stage of the child. Child-tailored progression was also achievable by the individual coaching and could be made by changing temporal factors, spatial factors, sensory conditions, components, or composition.

Statistical analysis

All statistical analyses were completed in JMP® Software (SAS, 2017). Pre- and post-intervention data and follow-up data were analysed using a linear mixed model (Appendix 4). A 0.05 level of significance was applied to determine the effect of the intervention on the different dependent outcome measures (Kids-BESTest, TGMD-3, COPM en CBSK). Post hoc analyses were conducted, using Tukey HSD, to determine between which specific test moments a significant time effect could be observed. To identify whether there are specific groups of children that benefit more from the intervention, covariates have also been added to the analysis. These covariates include the following: sex, TGMD-3 LM at T0, MABC-2 balance at baseline, Kids-BESTest scores at T0 (> 80% or < 80%), comorbidities (ASD and/or ADHD) and age (young (6-9 years) versus old (10-12 years)) (Appendix 5).

All acquired data was pseudonymised and collected in a long-format data sheet. For the Kids-BESTest, raw scores per age band were used and converted to percentages. The data from the total TGMD-3 and the subscales (locomotor and ball skills) are age-specific scaled scores. The data of the CBSK are percentages based on sex- and age-specific norm scores and the data of the COPM are raw scores.

In addition to test statistics, descriptive statistics (means and standard deviations) were also conducted to characterise the participants and performances at the different test times.

Results

Patient characteristics

In total 20 children (4 girls and 16 boys) between 6.4 and 12.6 years old (mean (SD) = 8.8 (1.7)) were included. All participants completed all test moments. Their characteristics at inclusion regarding age, sex and diagnosis as well as their scores on the DCD-Q and performances on the Kids-BESTest and MABC-2 balance subscale are presented in Table 4.

Table 4
Characteristics of Participants Based on Inclusion Criteria

Subject	Age	Sex	Diagnosis	DCD-Q score	Kids-BESTest score baseline (%)	MABC-2 balance score baseline (pct)
1	7.3	M	DCD	24	62	2
2	7.3	M	pDCD	31	68	0.1
3	9.9	M	DCD	31	64	1
4	8.3	M	pDCD	34	70	25
5	6.4	M	DCD	18	45	0.1
6	8.0	M	pDCD	38	60	2
7	8.3	F	DCD	44	72	25
8	6.7	F	pDCD	35	69	9
9	9.7	M	pDCD	28	66	1
10	8.2	M	pDCD	19	73	5
11	7.5	F	DCD	27	59	16
12	11.0	M	DCD	24	71	9
13	9.6	M	pDCD	33	66	16
14	8.7	F	pDCD	34	67	1
15	11.2	M	DCD	31	54	0.1
16	7.9	M	pDCD	31	67	9
17	12.4	M	DCD	29	68	2
18	7.7	M	pDCD	38	67	0.5
19	11.0	M	DCD	37	67	1
20	6.8	M	DCD	33	63	9
Group	8.8 (1.7)*	4F/16M	10/10	30.9 (6.3)*	65 (6)*	6.7 (7.9)*

Note. M: male; F: female, DCD: Developmental Coordination Disorder; pDCD = probable DCD, baseline: 6 months before camp, *: mean (SD).

Effect of the intervention

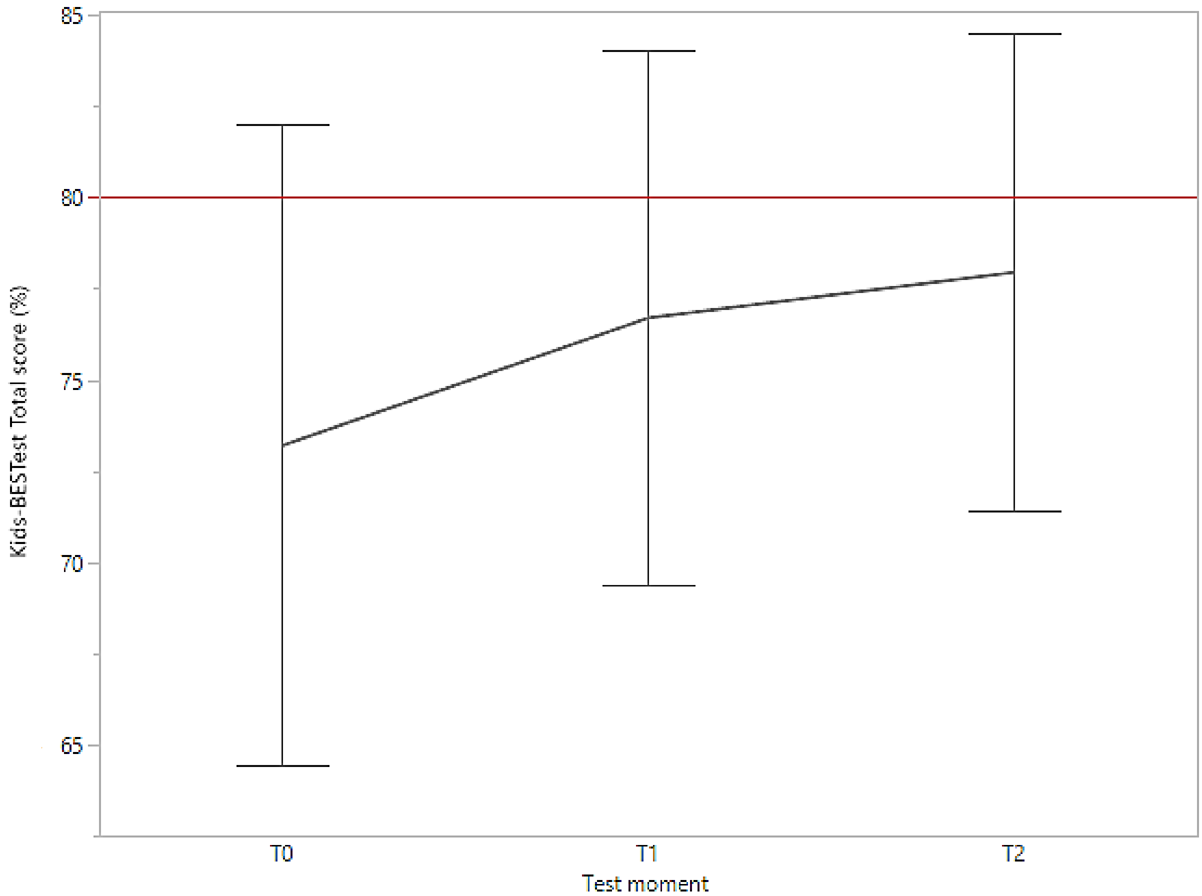
Postural control

Total scores on the Kids-BESTest changed significantly over time ($F_{(2,18)}$= 4.90; p = 0.0199) at both post-intervention (+ 4% (6%)) and at follow up (+ 1% (5%)) (Figure 2), compared to the mean pre-intervention score (73% (9%)). The post hoc analysis showed significant changes between T0 and T1 (p = 0.046), and between T0 and T2 (p = 0.015), but not between T1 and

T2 (p = 0.555). This outcome depends significantly on the scores of the Kids-BESTest at T0 ($F_{(1,18)}$= 15.35; p = 0.001). Children with a lower Kids-BESTest score at T0 show a greater improvement (Appendix 6).

Figure 2

Mean Kids-BESTest Total Score vs. Test Moment



Note. Significant (p<0.05) time effect between T0 and T1, and T0 and T2; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Regarding the subdomains of the Kids-BESTest, significant changes over time were found for the anticipatory postural adjustments ($F_{(2,18)}$= 3.89; p = 0.039), reactive postural responses ($F_{(2,18)}$= 29.48; p = <0.0001), and the stability in gait ($F_{(2,18)}$= 4.07; p = 0.035). Post hoc analysis showed a significant change between T0 and T1 for anticipatory postural adjustments (p = 0.047), and between T0 and T2 for reactive postural responses (p = <0.0001) and stability in gait (p = 0.024). No significant time effect was found for biomechanical constraints ($F_{(2,18)}$=

1.99; p = 0.165), stability limits and verticality ($F_{(2,18)}$= 0.05; p = 0.953), and sensory orientation ($F_{(2,18)}$= 2.95; p = 0.078).

All domains, except for sensory orientation, were influenced by the scores of the Kids-BESTest at T0 (Appendix 7). For stability limits and verticality, the changes were also significantly influenced by the sex of the child (p = 0.023), where girls had a greater improvement than boys (Appendix 8), and the score of the TGMD-3 LM at T0 (p = 0.02), where average and below average scores show a general increase, while the children who had a borderline impaired and impaired score show a slight decrease (Appendix 9). Sensory orientation was influenced by the score of the TGMD-3 LM at T0 (p = 0.014), where there was a positive effect between T0 and T1, but a negative effect between T1 and T2 (Appendix 10), and by the comorbidity of ADHD (p = 0.026), where a greater decrease is noticed for children with ADHD between T1 and T2, than for children without ADHD (Appendix 11).

Motor skills

Total scores on the TGMD-3 did not improve significantly over time ($F_{(2,18)}$= 2.21; p = 0.139) after intervention (-0.4 (3.63)) and at follow-up (+1.65 (3.69)) compared to the mean pre-intervention score (9.9 (3.51)). The extent of this effect does depend significantly on the score of the TGMD-3 LM at T0 ($F_{(3,16)}$= 8.76, p = 0.001). Additionally, no time effects were found for the TGMD-3 subscales (LM: $F_{(2,18)}$ = 0.03; p = 0.972; BS: $F_{(2,18)}$ = 3.18; p = 0.065).

Self-perceived competence

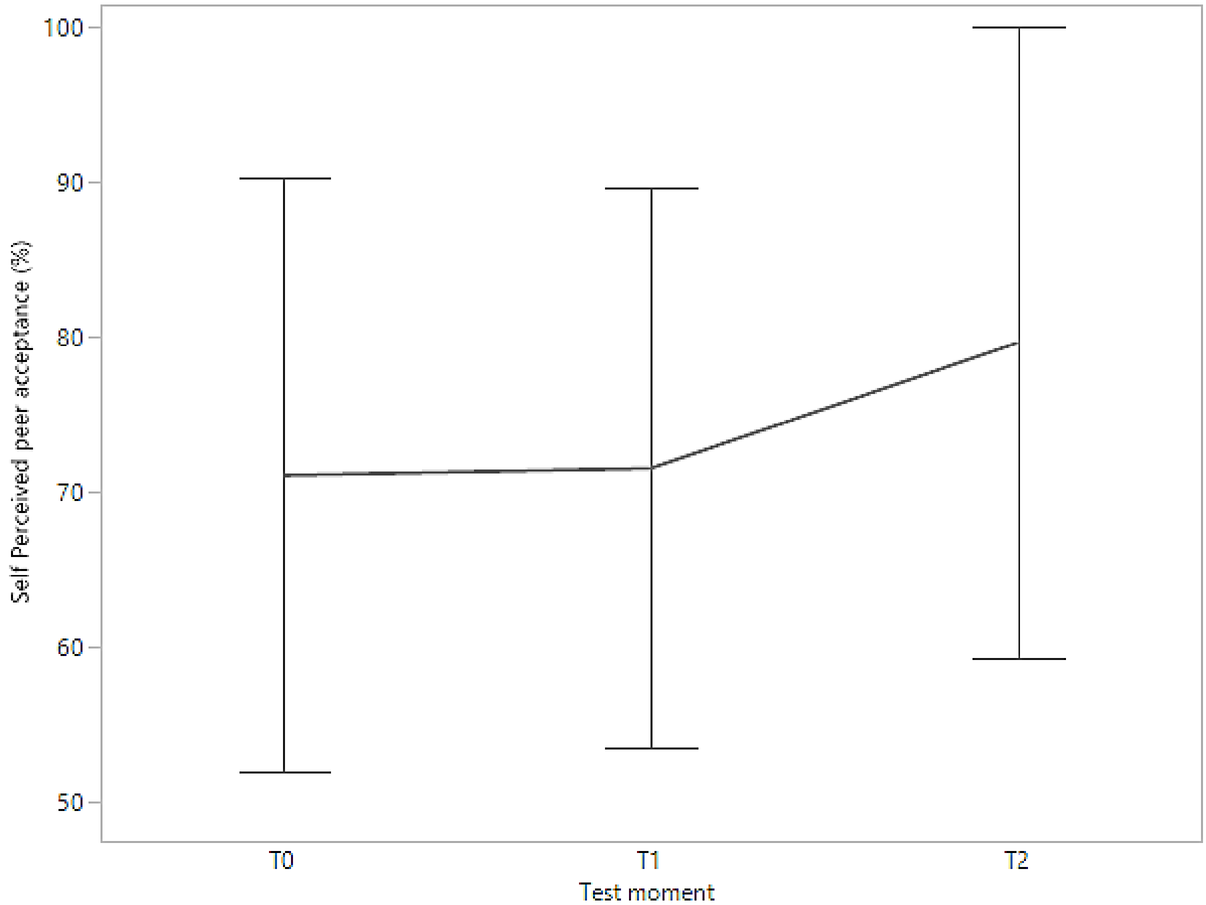
For the subscale physical competence, no significant time effect was found ($F_{(2,17)}$= 0.25, p = 0.781) for both post-intervention (+0.44 (10.20)) as for follow up (+1.31 (10.50)). This outcome scale was not influenced by other factors.

However, there was a significant time effect found for the subscale peer acceptance ($F_{(2,17)}$ = 4.44, p = 0.028), both for post-intervention (+0.45 (11.78)), as for follow-up (+8.09 (12.83)) (Figure 3). Post hoc analysis shows an increase between T0 and T2 (p = 0.035), and between T1 and T2 (p = 0.035). This outcome scale was not influenced by other factors.

Additionally, a significant change over time was found for the cognition subscale ($F_{(2,17)}$= 4.04, p = 0.037) (Figure 4). However, post hoc analysis does not show significant effects between T0, T1 or T2. This outcome scale was influenced by the sex of the child (p = 0.012), where girls show a greater increase than boys between T1 and T2 (Appendix 12); the scores of the Kids-BESTest at T0 (p = 0.007), where children who score below 80% show a more consistent improvement than children who score above 80% on the Kids-BESTest at T0 (Appendix 13); having an ADHD comorbidity (p = <0.0001), where children with ADHD show an overall higher score than children without ADHD (Appendix 14); and the MABC-2 balance baseline (p = 0.002), where children who have a higher balance baseline score on the MABC-2, show a greater increase between T1 and T2 (Appendix 15).

Figure 3

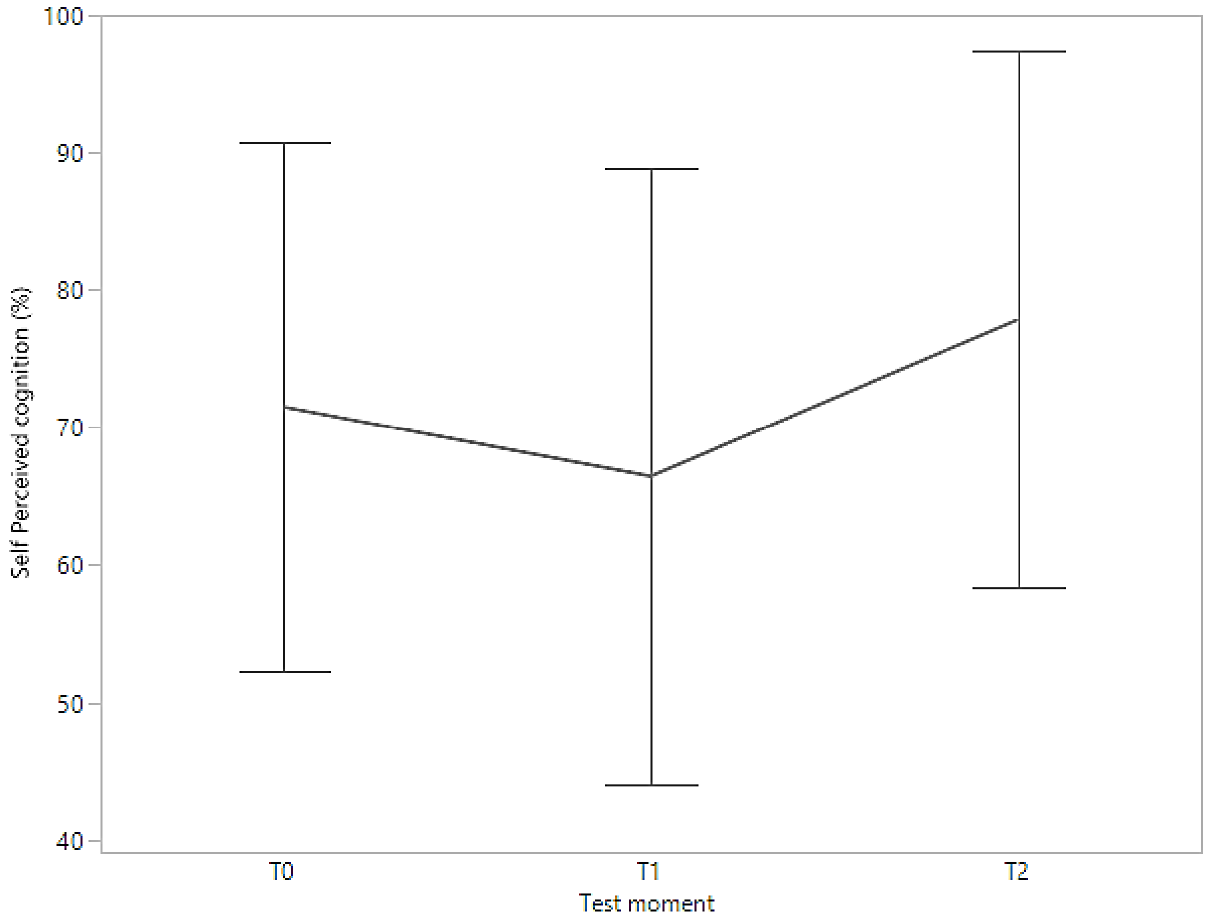
Mean Self Perceived Peer Acceptance vs. Test Moment



Note. Significant ($p<0.05$) time effect between T0 and T2, and T1 and T2; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Figure 4

Mean Self Perceived Cognition vs. Test Moment



Note. A general significant (p<0.05) time effect, no significant time effect between each test moment; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

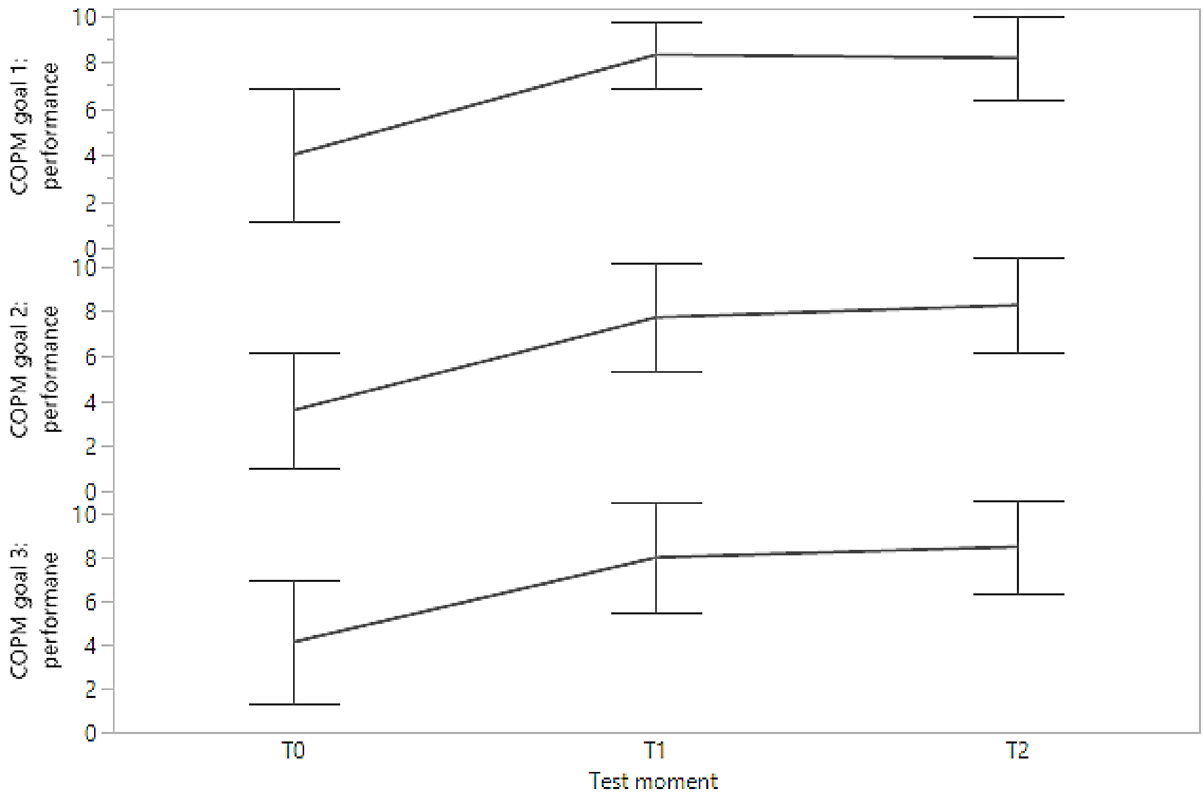
Individual goals

With regard to the intervention goals, formulated by the parents in the COPM, there was a significant change in scores over time for both performance scores (Goal 1: $F_{(2,18)}$= 15.65; p = 0.0001, Goal 2: $F_{(2,18)}$= 23.33; p = <0.0001, Goal 3: $F_{(2,14)}$= 11.79; p = 0.001) (Figure 5) and satisfaction scores (Goal 1: $F_{(2,18)}$= 21.16; p = <0.0001, Goal 2: $F_{(2,18)}$= 14.36; p = 0.0002, Goal 3: $F_{(2,14)}$ = 17.71; p = 0.0001) (Figure 6). Post hoc analyses showed that the intervention provides an immediate increase in scores. This improvement continues to persist after 3 months, however, there is no additional enhancement observed between T1 and T2. P-values can be found in Appendix 7.

The significant increase in these scores is influenced by a variety of factors. We observe, for example, that the scores of goal 1 satisfaction (p = 0.044) and goal 2 satisfaction (p = 0.008) of the children without ASD significantly increase more between T0 and T1 than the scores of the children with ASD (Appendix 16 and 17). For goal 2 performance score, we see the opposite between T0 and T1 (p = 0.024) (Appendix 18). An interaction effect was found for ASD and the performance score of COPM goal 2 (p = 0.007). We also see significant differences over time in satisfaction scores for goal 3 of children with ADHD and children without ADHD (p = 0.002). Children without ADHD have a greater improvement over time than children with ADHD (Appendix 19). Furthermore, the baseline score on the MABC-2 balance scale at initial testing also determines the degree of improvement in scores. The increase between T0 and T1 is for both satisfaction (p = 0.03) and performance (p = 0.014) score of goal 2 much the same, but there is a difference between the children who scored below the fifth percentile and the children who scored above the fifth percentile between T1 and T2 (Appendix 20 and 21). Finally, we see that the effect on satisfaction scores in goal 3 also depends on sex (p = 0.017). In fact, for boys we see a slightly stronger increase in scores than for girls (Appendix 22).

Figure 5

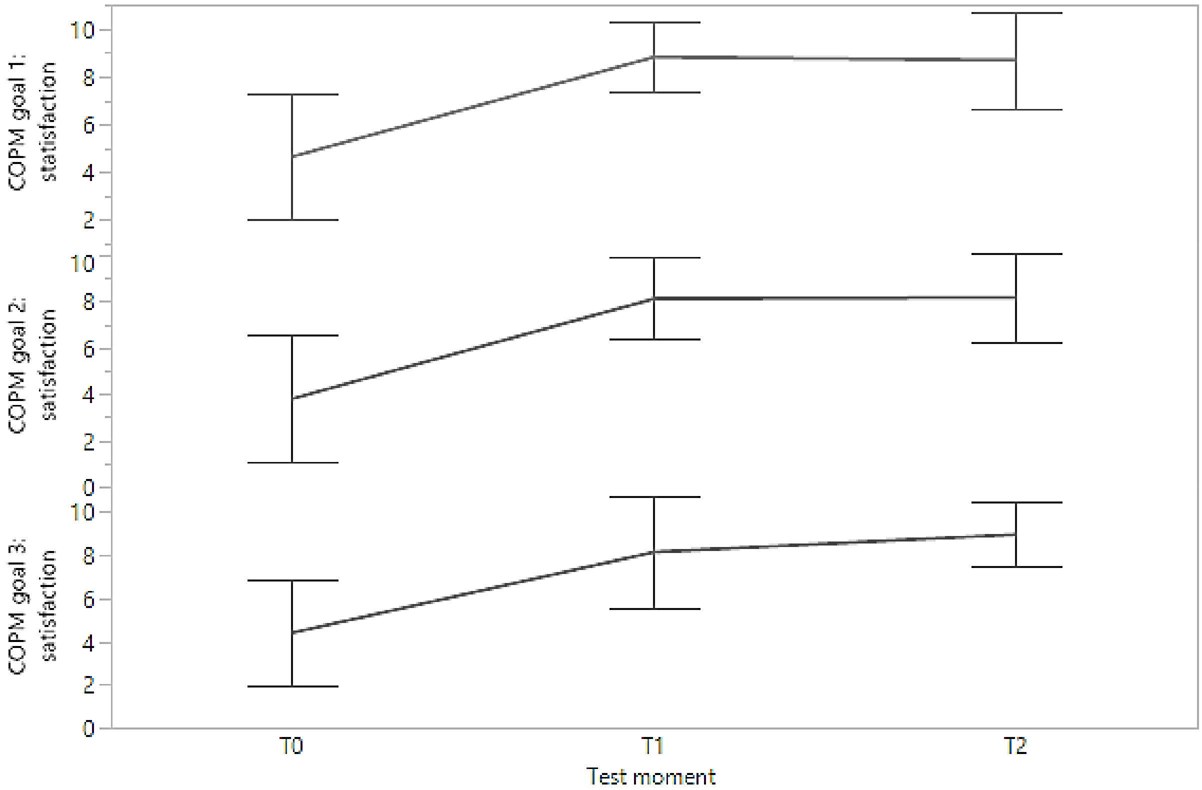
Mean COPM Goals (Performance) vs. Test Moment



Note. Significant (p<0.05) time effect for all three goals between T0 and T1, and T0 and T2; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Figure 6

Mean COPM Goals (Satisfaction) vs. Test Moment



Note. Significant ($p<0.05$) time effect for all three goals between T0 and T1, and T0 and T2; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Discussion

This study was designed to determine the short- and medium-term effect of a highly intensive and task-oriented intervention program on PC in children with DCD. Additionally, the effect of this intervention on the perceived competence, the motor skills, and the individual goals of the children with DCD was investigated.

Our first hypothesis can be confirmed. Results on the Kids-BESTest improved significantly immediately after camp and this improvement also persisted three months after the intervention. Significant improvements were found in three different domains: anticipatory postural adjustments, reactive postural responses, and stability in gait. The children's motor skills did not improve significantly in contrast to the individual goals, all of which did improve significantly. Finally, we see significant improvements in two of the three self-perceived competence domains, namely peer acceptance and cognition. With this we can also confirm that a HII has other positive effects besides the positive effect on PC.

<u>Postural Control</u>

The significant improvements in PC resulting from this HII are in line with results of previous studies (Dannenbaum et al., 2022; Zwicker et al., 2015). However, different outcome measurements were used. Dannenbaum et al. (2022) focused on vestibular related outcome measurements, and Zwicker et al. (2015) focused on functional motor goals, self-efficacy and participation. In both these studies, the age range was the same as in our study and the same inclusion criterion related to the MABC-2 was used, making the severity of DCD in the children approximately the same. Dannenbaum's (2022) intervention is also characterized by a high participant-therapist ratio (2:1) which may suggest that this is also an important aspect to include in a protocol to improve motor skills and PC in children with DCD. Finally, both interventions have a number of characteristics of task-oriented training which is similar to our task-oriented training. Dannenbaum et al. (2022) focused specifically on vestibular function, but he did use an intervention that has some aspects in common with the task-oriented approach. Zwicker et al. (2015) used a task-oriented approach and cognitive strategies (CO-OP) to design the intervention used in their study. These results emphasize that a HII has positive effects on function-, activity- en participation-level in children with DCD.

With these results, we can also confirm that PC can be trained effectively with a task-oriented approach in children with DCD. A task-oriented intervention seems to have positive results concerning functional outcomes and performance speed, and it seems to be more efficient than process oriented approaches (Smits-Engelsman et al., 2013). It is important to note that these studies did not focus specifically on PC, but did include the child specific, individual goals.

Another finding is that the significant improvements on the total scores of the Kids-BESTest and on the three domains anticipatory postural adjustments, reactive postural responses, and stability in gait significantly depend on the Kids-BESTest scores at T0. It seems as if the children with a Kids-BESTest T0 score <80%, benefit more from the intervention than children with a score >80%. These results are in line with the results of the study of Pardasaney et al. (2012) in which community dwelling older adults with a lower baseline score on balance tests (Dynamic gait index, Berg Balance Scale, and Performance-Oriented Mobility Assessment total scale and balance subscale), had a greater improvement in balance than their peers.

<u>Motor skills</u>

Contrary to expectations, where motor skill improvements were found in children with DCD (Rameckers et al., 2023), this study did not find a significant effect of the intervention on the total scores of the TGMD-3 and the scores of the subscales of the TGMD-3. It must be considered that the TGMD-3 scores depend on the quality of the movement. It may be possible that the children may be able to sustain an activity longer due to the intervention, but their movement quality stayed the same. The quality-based scoring is effective to identify movement problems within children with DCD, but may be too strict to detect time effects for this measurement.

Scores on the subscale locomotor skills were influenced by the comorbidity of ADHD. This finding can be attributed to the fact that in 50% of children with ADHD, gross and fine motor difficulties can be found (Kaiser et al., 2015). In addition, children with ADHD often have comorbidities, such as DCD (Brossard-Racine et al., 2012; Fliers et al., 2008). ADHD affects executive functions such as working memory, motor planning, attention, and self-regulation. The combination of ADHD and DCD makes it extra difficult for the child to coordinate their movement and activities (Fliers et al., 2008).

For the subscale ball skills, the scores depended on the age of the child. In the group of the older children, there was more improvement possible than in the younger group. However, the subscale itself did not change significantly. This could be because the intervention does not focus on ball skills specifically, but on PC. Additionally, the ball games for the older group were often made a little more difficult.

Self Perceived Competence

Another important finding is the significant effect of the intervention on the peer acceptance subscale of the CBSK. Children felt more accepted by their peers after the intervention. This effect was also found in Caçola et al. (2016), where only in the group that received task-oriented training in a large group with the focus on collaboration, a decrease in peer problems was noted. On the other hand, higher levels of anxiety were found in the children in this group, in contrast to the children in the other group that did goal-based activities in small groups, where anxiety levels decreased. Based on these results, we may assume that varying the group size of the activities during our intervention was a good idea, provided that there is individual guidance to adjust each activity based on the needs and skill level of the child.

Additionally, the cognition subscale improved significantly. The children with an ADHD comorbidity seem to score higher on this subscale, even at T0, compared to their peers without the ADHD comorbidity. A possible explanation for this might be the positive illusory bias (PIB). PIB describes a discrepancy between the actual abilities and the self-perceived abilities of the child. The mechanisms behind PIB are not yet fully discovered, but it is shown that children with ADHD often overestimate themselves (Crisci et al., 2022; Emeh et al., 2018; Fliers et al., 2010) Additionally, post hoc analysis does not show significant effects between T0, T1 or T2. A larger group sample is necessary to interpret post hoc analysis.

Individual goals

Lastly, a significant and clinical relevant improvement was reported for all individual goals of the COPM. Each child received individualized attention to practice these goals specifically, which may explain these results. A great amount of time on task and individual adaptations is beneficial for children to improve their goals (van Empelen, 2016). Between T1 and T2, no further increase is reported. This can be attributed to the fact that no specific attention and training to the individual goals has been provided. Our findings are consistent with those of Krajenbrink et al. (2022) and Zwicker et al. (2015). They also used the COPM as an outcome measure and found an improvement in satisfaction and performance scores of the individual goals in children with DCD after a HII (Krajenbrink et al., 2022; Zwicker et al., 2015).

The comorbidity of ASD, MABC-2 balance scores at baseline and sex influenced the improvement on the individual goals with more improvement for children without ASD, lower MABC-2 balance baseline scores and boys.

To conclude, DCD cannot be cured, but even with a smaller time duration of individual training, children felt more satisfied with their activity performance, which may break the vicious cycle of inactivity, often observed in children with DCD (Yu et al., 2021).

Limitations

The results of the study may have been affected by some limitations, but certain weaknesses in turn had benefits. First of all, the sample size was quite small, raising the possibility that the reliability of the survey may not be sufficient. However, there was a low dropout rate. The intervention is safe, sustainable and feasible.

Secondly, during the process of measurements and data-collecting, a lot of different research-assistants were involved. This could lead to different interpretations and scoring. Nevertheless, these assistants received proper training from experts in the field, which minimizes errors. Additionally, video-material was collected during the testing, which made it possible to revise and correct any misinterpretations and to improve consistency.

Furthermore, there are some factors that may prevent all effects from being attributed with certainty to the intervention. There was a high comorbidity rate. Some children had a diagnosis of ASD or ADHD. In others, there was a strong suspicion of one of these diagnoses. There was also some heterogeneity within the study population, such as sex differences and the severity of DCD-related problems. These factors were, of course, considered as much as possible. For example, several activities were done in smaller groups, which makes that the difference in age could be a lesser influencing factor. In addition there is the advantage of the participant-therapist ratio. Each child was closely supervised by one therapist. This ensured that the exercises could be adjusted based on the severity of the DCD. Even though we took these factors into consideration, the effect may still be underestimated due to the small sample size.

Finally, this study executes a follow-up assessment at three months post-intervention. To gain better insight on long term changes, a second follow-up could be considered. However, the three month-follow up makes it possible to already notice some changes, improvements or declines, shortly after the intervention. But this could also be attributed to individual physiotherapy between these test moments (T1 and T2). Whether the children followed this individual therapy was not registered as a covariate within this study. Further studies on the long-term effects of a highly intensive therapy on PC in children with DCD can be proposed, using a larger sample size. In addition, the intervention is of relatively short duration, so further research on the effects of a camp of longer duration on PC could also be conducted. It would also be useful to conduct a study, investigating whether a camp is more effective than the individual therapy of children with DCD.

Conclusion

This study found that a highly intensive task-oriented intervention camp is effective to improve PC, individual goals and self-perceived peer acceptance and cognition in children with DCD. Further research is necessary to find clear guidelines to improve gross motor skills and self-perceived physical competence.

Overall, this study strengthens the idea that children with DCD benefit from an individualized approach during their rehabilitation to improve personal goals. Additionally, group sessions can be considered to implement into the rehabilitation plan, but with adequate attention for the individual needs towards progression and difficulty level. The results of this research support the idea that the framework of PC needs to be considered when developing therapeutic activities for this population. A high time on task, a lot of repetition and a highly intensive protocol will be beneficial for children with DCD.

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Appendices

Appendix 1

*Framework of postural control**

Domain	Definition
Biomechanical restraints	The quality of the BoS. It gives an idea about the ability to control the CoM within the LoS, without changing the BoS.
Movement strategies	All strategies a person can use to return the body to equilibrium while in a standing position (RPA) and to maintain stability during self-initiated movements (APA). I.e. Ankle strategy, hip strategy, stepping strategy
Sensory strategies	The integration of the somatosensory, visual and vestibular systems. These sensory integrations make it possible to interpret complex sensory environments.
Control of Dynamics	Balance during gait and while changing positions. I.e. Control of the CoM over a moving body
Orientation in space	The orientation of body parts within space, with respect to gravity, the support surface, internal references, and visual input. This depends on the context, environment and the given task.
Cognitive processing**	Can impact the quality of dual tasks and movement, task duration, and the fluency of coordination. I.e. Attention, memory, knowledge, decision-making planning, reasoning, judgment, perception comprehension, language and visuospatial function

*As described in Horak et al. (2006) and **Dhakal et al. (2024)

Note. CoM (center of mass), LoS (Limits of stability), BoS (Base of Support), APA (anticipatory postural adjustment), RPA (reactive postural adjustment).

Appendix 2

*Activity Categories**

Activity category	Description	Examples
Jumping	Activities involve jumping in a broad context and different sensory situations (stable and unstable surfaces), unipedal and bipedal jumping, with and without different dual tasks (cognitive, motor, auditive).	• Personate different animals while jumping on a trampoline • Relay race on an airtrack on one leg while keeping a balloon in the air
Sitting balance	Activities are divided in static and dynamic sitting balance. Static sitting balance activities are performed on the ground, stools or benches with a stable or unstable surface and without backrest. While children sit, games, crafting, cooking activities are performed. In the dynamic sitting balance activities children sit on a moving surface such as sitting on a moving burlap bag or riding a balance bike (unicycle with small steering wheels). Dual tasks (cognitive, motor, auditive) are added to increase complexity.	Static • Sitting on a gymball and crafting juggling balls • Cutting vegetables while sitting on a bench without backrest Dynamic • Performing a complex trail on a balance bike while catching balls that are thrown unexpectedly • Sitting on a burlap bag that is pulled by the individual therapist and remember puzzle pieces
Walking and running	Activities consist of games where children have to reach goals by walking and running. This can be on stable or unstable surface, eyes open or closed, with or without dual tasks, forward, backward or sideward etc.	• Relay with different running activities. Children have to remember puzzle pieces at the end to reconstruct a puzzle. • Perform a complex trail backwards
Circus	Activities include specific circus activities and are performed individually, in duo or in group. Manual circus activities, such as plate spinning or juggling, can be performed as a dual task.	• Barrel walking, if possible combined with throwing a ball • Stand or walk on a firm circus ball
Individual goals	Children choose up to three individual balance goals before the camp. Therapy starts from task performance analysis and is individually adapted using motor learning principles.	• “I want to learn rope skipping” • “I want to learn how to inline skate”
Group activities with focus on social interaction	The focus is on social interaction, children have to work together to reach goals or win games.	• Perform a complex and unstable trail with the whole group • Playing tag and remember memory cards at the same time

*adopted from Protocol Paper (Velghe et al., 2024).

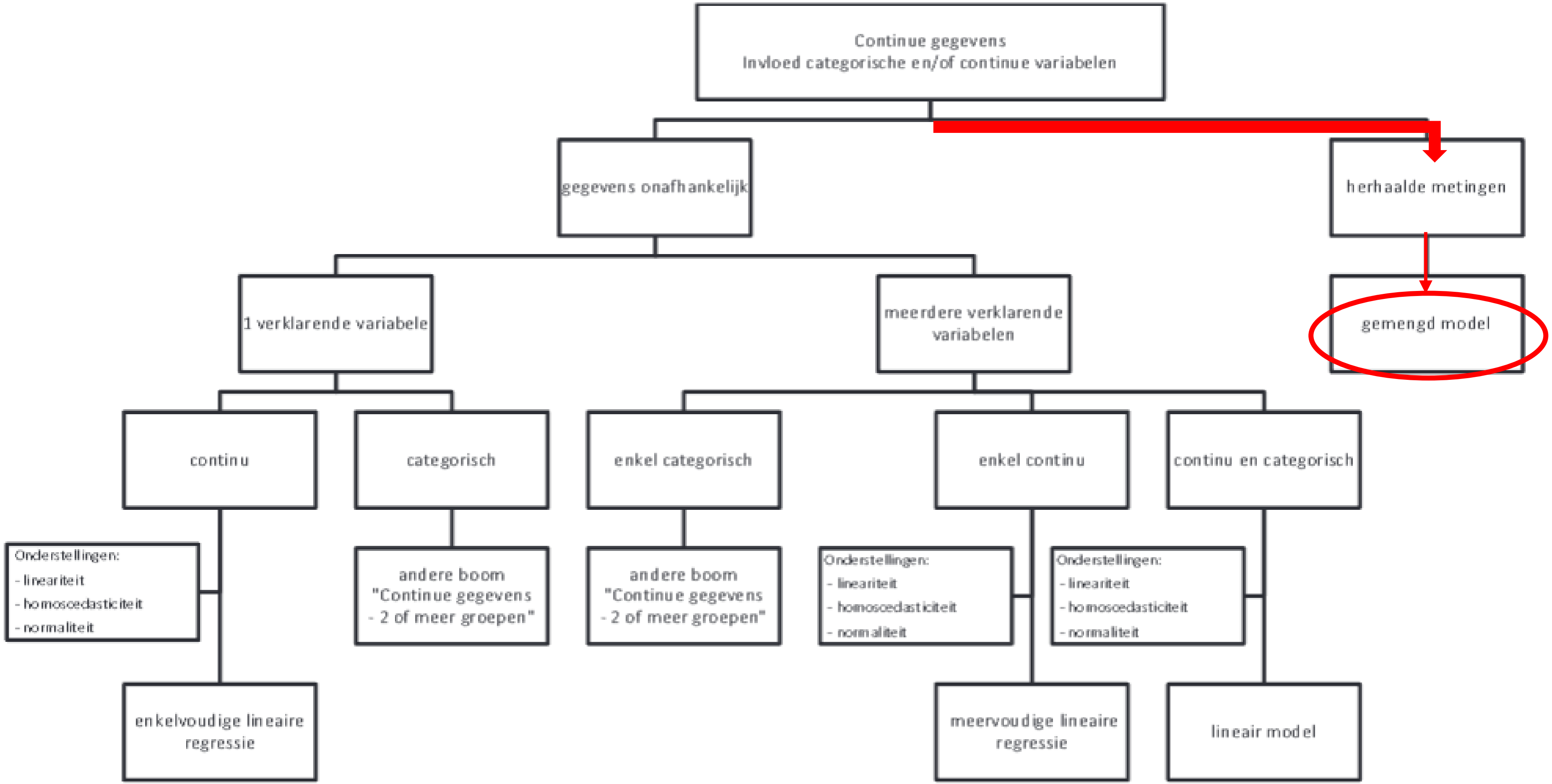
Appendix 3

Schedule of Intervention Sessions

Time	Training component
8:00 – 9:00	Pre camp care
9:00 – 9:45	Activity 1
9:45 – 10:00	Break
10:00 – 10:45	Activity 2
10:45 – 11:00	Break
11:00 – 11:45	Activity 3
11:45 – 12:45	Lunch break
12:45 – 13:30	Activity 4
13:30 – 13:45	Break
13:45 – 14:30	Activity 5
14:30 – 14:45	Break
14:45 – 15:30	Activity 6
15:30 – 15:45	Break
15:45 – 16:30	Activity 7
16:30 – 17:00	Relaxation + day closing
17:00 – 18:00	After camp care

Appendix 4

Decision Tree Statistical Analysis – Linear Mixed Model



Appendix 5

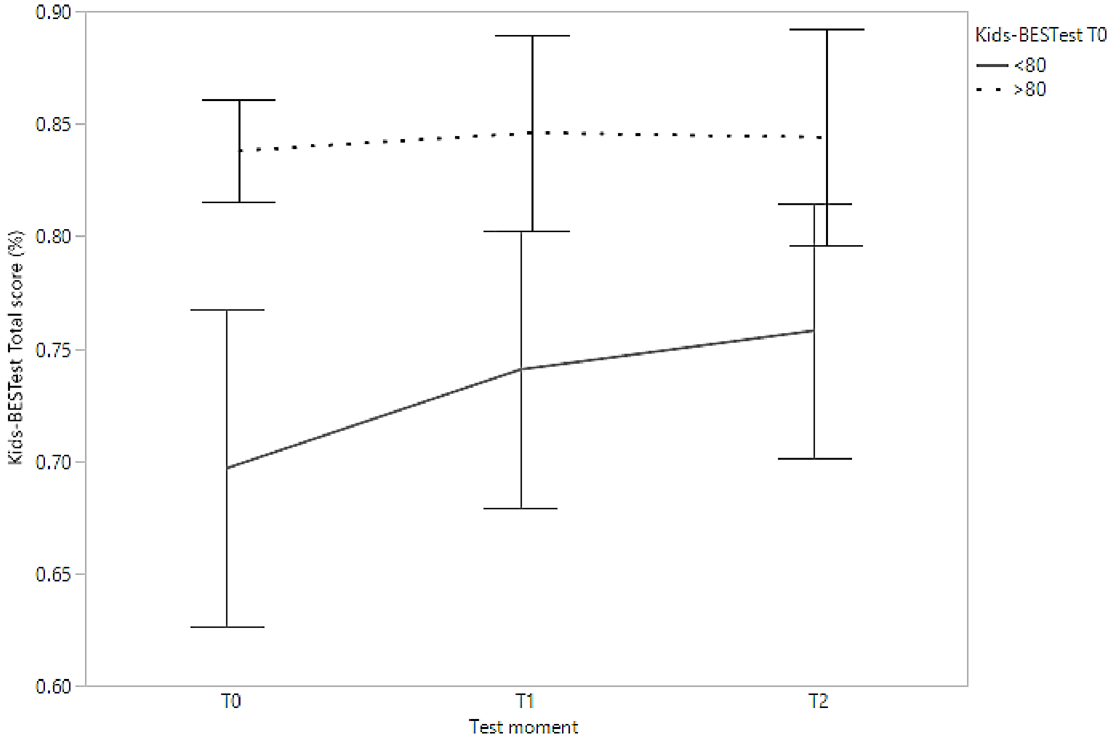
Covariates

Subject	Age	Gender	Comorbidity	Kids-BESTest score T0 (%)	MABC-2 balance score baseline (pct)	TGMD-3 LM score T0 (scaled)
1	7.3	M	ADHD	77	2	4
2	7.3	M	ADHD	75	0.1	5
3	9.9	M	ASD	65	1	6
4	8.3	M	COMB	68	25	1
5	6.4	M	NO	51	0.1	1
6	8.0	M	NO	74	2	4
7	8.3	F	ADHD	84	25	7
8	6.7	F	NO	75	9	9
9	9.7	M	NO	62	1	6
10	8.2	M	NO	71	5	6
11	7.5	F	NO	73	16	9
12	11.0	M	ASD	84	9	5
13	9.6	M	ASD	78	16	4
14	8.7	F	NO	85	1	5
15	11.2	M	ASD	64	0.1	4
16	7.9	M	ASD	68	9	8
17	12.4	M	COMB	06	2	7
18	7.7	M	NO	74	0.5	5
19	11.0	M	ADHD	80	1	6
20	6.8	M	ASD	70	9	6
Group	8.6 (1.7)*	4F/16M	4ADHD/6ASD/ 2COMB/8NO	73 (9)*	6.7 (7.9)*	5.4 (2.1)*

Note. M: male; F: female; ADHD: Attention Deficit Hyperactivity Disorder; ASD: Autism Spectrum Disorder; COMB = combination of ADHD and ASD, NO = no comorbidity, *: mean (SD).

Appendix 6

Kids-BESTest Total Score vs. Test Moment, with Kids-BESTest Scores at T0 Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Appendix 7

Results

Y-variables	T0	T1	T2	Time effect	Pairwise comparison	Significant covariates
Kids-BESTest	73% (9%)**	77% (7%)	78% (7%)	F : 4.90 P : 0.0199*	T0-T1: 0.046* T0-T2: 0.015* T1-T2: 0.555	**Kids-BESTest T0:** F: 15.35 P: 0.001
Dom 1	91% (7%)	97% (5%)	87% (9%)	F: 1.99 P: 0.165	T0-T1: 1.000 T0-T2: 0.152 T1-T2: 0.203	**Kids-BESTest T0:** F: 4.94 P: 0.039
Dom 2	67% (8%)	67% (9%)	68% (11%)	F: 0.05 P: 0.953	T0-T1: 0.983 T0-T2: 0.947 T1-T2: 0.981	**Sex:** F: 7.18 P: 0.023 **Kids-BESTest T0:** F: 7.11 P: 0.024 **TGMD-3 LM T0:** F: 5.23 P: 0.02
Dom 3	64% (14%)	71% (12%)	66% (13%)	F: 3.89 P: 0.039*	T0-T1: 0.047* T0-T2: 0.888 T1-T2: 0.302	**Kids-BESTest T0:** F: 20.62 P: 0.0003
Dom 4	68% (16%)	70% (15%)	86% (12%)	F: 29.48 P: <0.0001*	T0-T1: 0.860 T0-T2: <0.0001* T1-T2: 0.004*	**Kids-BESTest T0:** F: 5.79 P: 0.027
Dom 5	90% (15%)	95% (10%)	91% (10%)	F: 2.95 P: 0.078	T0-T1: 0.261 T0-T2: 0.997 T1-T2: 0.328	**TGMD-3 LM T0:** F: 4.94 P: 0.014 **ADHD comorbidity:** F: 6.1 P: 0.026
Dom 6	59% (17%)	67% (19%)	70% (11%)	F: 4.07 P: 0.035*	T0-T1: 0.31 T0-T2: 0.024* T1-T2: 0.58	**Kids-BESTest T0**: F: 15.37 P: 0.001

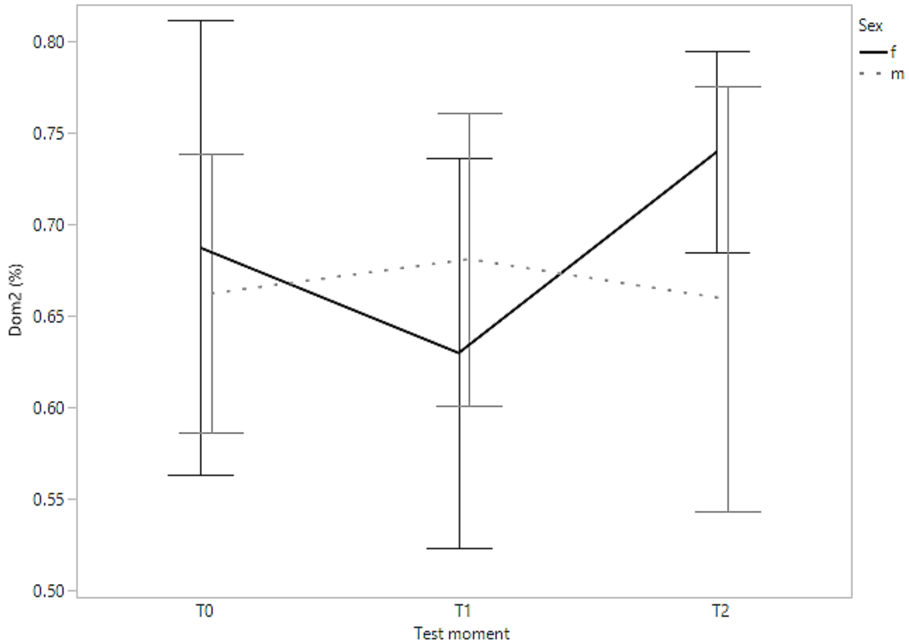
CBSK PC	74.78% (18.14%)	75.23% (15.92%)	76.54% (16.57%)	F: 0.25 P: 0.781	T0-T1: 0.98 T0-T2: 0.765 T1-T2: 0.851	/
CBSK SA	71.06% (19.12%)	71.51% (18.02%)	79.6% (20.31%)	F: 4.44 P: 0.028*	T0-T1: 0.985 T0-T2: 0.035* T1-T2: 0.035*	/
CBSK SS	71.49% (19.31%)	66.44% (22.41%)	77.84% (19.55%)	F: 4.03 P: 0.037*	T0-T1: 0.565 T0-T2: 0.13 T1-T2: 0.057	**Sex:** F : 8.73 P: 0.012 **Kids-BESTest T0:** F: 10.38 P: 0.007 **ADHD comorbidity:** F: 48.72 P: <0.0001 **MABC-2 balance baseline:** F: 9.46 P: 0.002
TGMD-3	9.9 (3.51)	9.5 (4.02)	11.15 (4.07)	F: 2.21 P: 0.139	T0-T1: 0.876 T0-T2: 0.248 T1-T2: 0.141	**TGMD-3 LM T0:** F: 8.76 P: 0.001
TGMD-3 LM	5.4 (2.14)	5.3 (2.25)	5.4 (2.46)	F: 0.03 P: 0.972	T0-T1: 0.981 T0-T2: 1.000 T1-T2: 0.978	**Kids-BESTest T0:** F: 8.1 P: 0.013 **TGMD-3 LM: T0** F: 228.54 P: < 0.001 **ADHD comorbidity:** F: 5.4 P: 0.036
TGMD-3 BS	4.5 (2.14)	4.2 (2.38)	5.75 (2.56)	F: 3.18 P: 0.065	T0-T1: 0.806 T0-T2: 0.078 T1-T2: 0.064	**Age:** F: 6.95 P: 0.019 **TGMD-3 LM T0:** F: 9.35 P: 0.001

COPM 1 per	4.03 (2.85)	8.33 (1.45)	8.18 (1.83)	F: 15.65 P: 0.0001*	T0-T1: <.0001* T0-T2: 0.0001* T1-T2: 0.842	/
COPM 1 sat	4.65 (2.62)	8.83 (1.48)	8.7 (2.03)	F: 21.16 P: <0.0001*	T0-T1: <.0001* T0-T2: 0.0003* T1-T2: 0.965	**ASD comorbidity:** F: 4.7 P: 0.044
COPM 2 per	3.6 (2.61)	7.73 (2.44)	8.28 (2.14)	F: 23.33 P: <0.0001*	T0-T1: 0.0004* T0-T2: <.0001* T1-T2: 0.577	**ASD comorbidity:** F: 6.3 P: 0.024 **MABC-2 balance baseline:** F: 4.92 P: 0.014
COPM 2 sat	3.8 (2.72)	8.13 (1.76)	8.18 (1.93)	F: 14.36 P: 0.0002*	T0-T1: 0.0001* T0-T2: 0.0002* T1-T2: 0.994	**ASD comorbidity:** F: 9.29 P: 0.008 **MABC-2 balance baseline :** F: 3.93 P: 0.03
COPM 3 per	4.13 (2.83)	7.97 (2.51)	8.47 (2.13)	F: 11.79 P: 0.001*	T0-T1: 0.001* T0-T2: 0.0005* T1-T2: 0.505	/
COPM 3 sat	4.41 (2.43)	8.16 (2.61)	8.97 (1.51)	F: 17.71 P: 0.0001*	T0-T1: 0.001* T0-T2: <.0001* T1-T2: 0.281	**Sex:** F: 7.48 P: 0.017 **ADHD comorbidity:** F: 14.15 P: 0.0024

Note. **Mean (SD); Dom: domain; Dom 1: Biomechanical Constraints: Dom 2: Limits of stability and verticality; Dom 3: Transitions and anticipatory postural adjustments; Dom 4: Reactive postural responses; Dom 5: Sensory orientation; Dom 6: Stability in Gait; CBSK: Competentie Belevingsschaal voor Kinderen; PC: physical competence; SA: social acceptance ; SS : school skills; TGMD-3: Test of Gross Motor Development; LM: locomotor scale; BS: ball skills scale; COPM: Canadian Occupational Performance Measure; per: performance; sat: satisfaction; T0: test moment right before camp; T1: test moment right after camp; T2: test moment 3 months after camp; *: significant at p<0.05 level.

Appendix 8

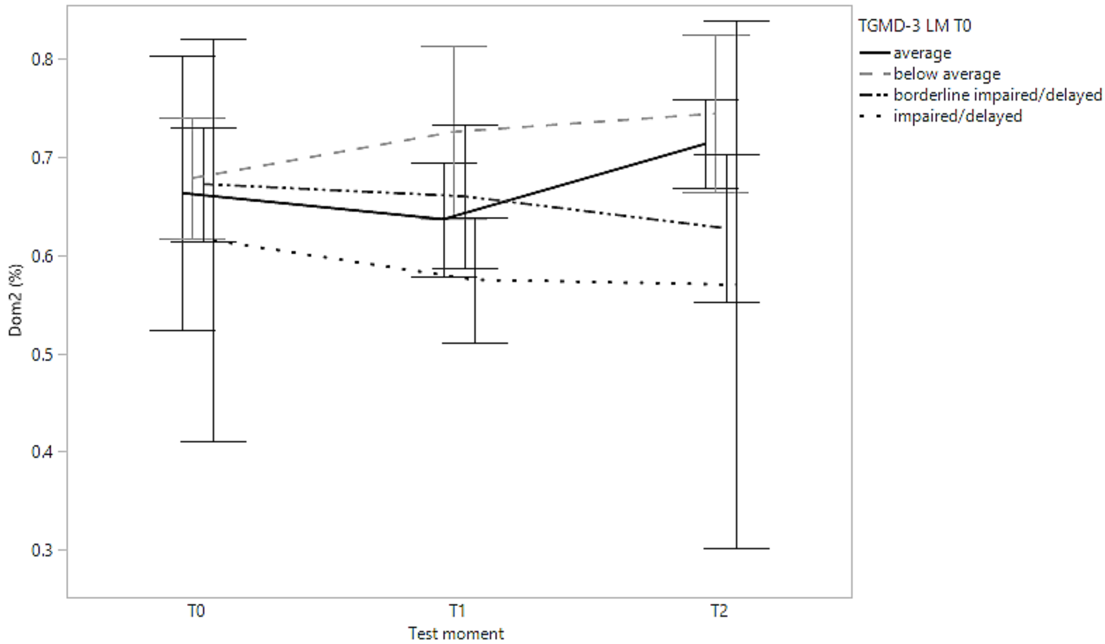
Domain 2 vs. Test Moment, with Sex Comparison



Note. Domain 2 = stability limits and verticality of the Kids-BESTest; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; f = female; m = male.

Appendix 9

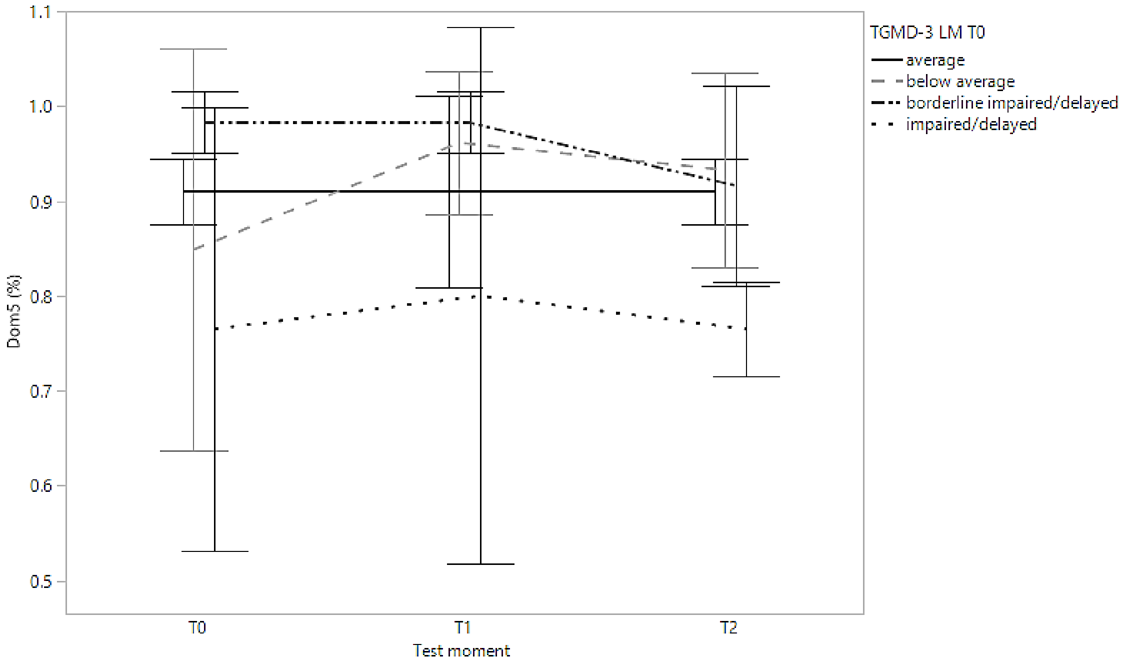
Domain 2 vs. Test Moment, with TGMD-3 LM Score at T0 Comparison



Note. Domain 2 = stability limits and verticality of the Kids-BESTest; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; LM = Locomotor subscale.

Appendix 10

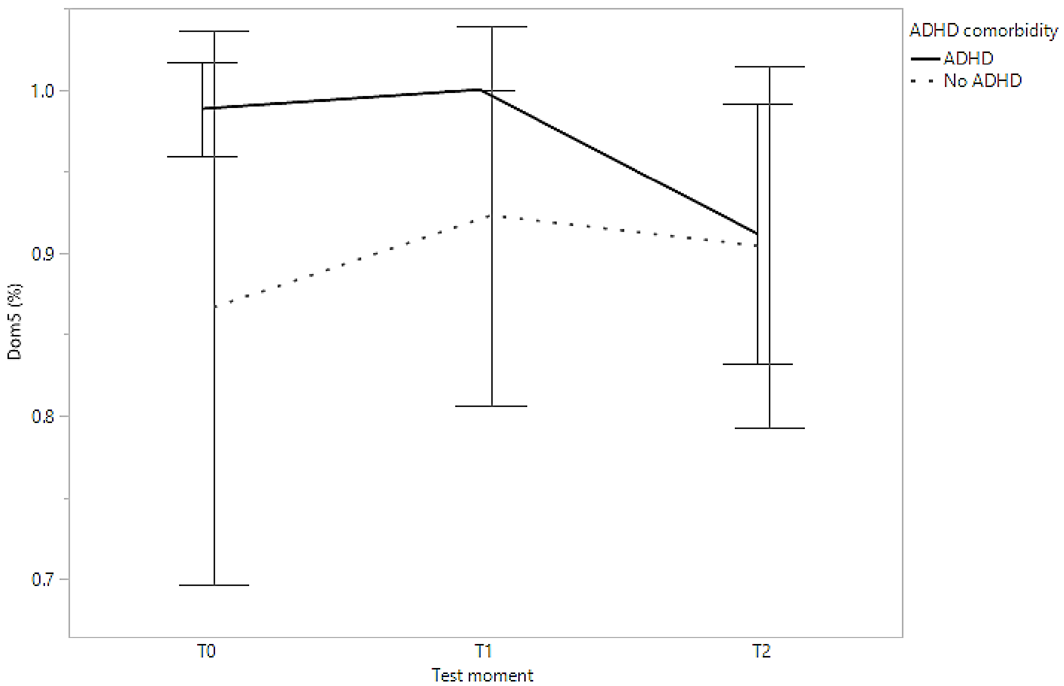
Domain 5 vs. Test Moment, with TGMD-3 LM Score at T0 Comparison



Note. Domain 5 = sensory orientation of the Kids-BESTest; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; LM = Locomotor subscale.

Appendix 11

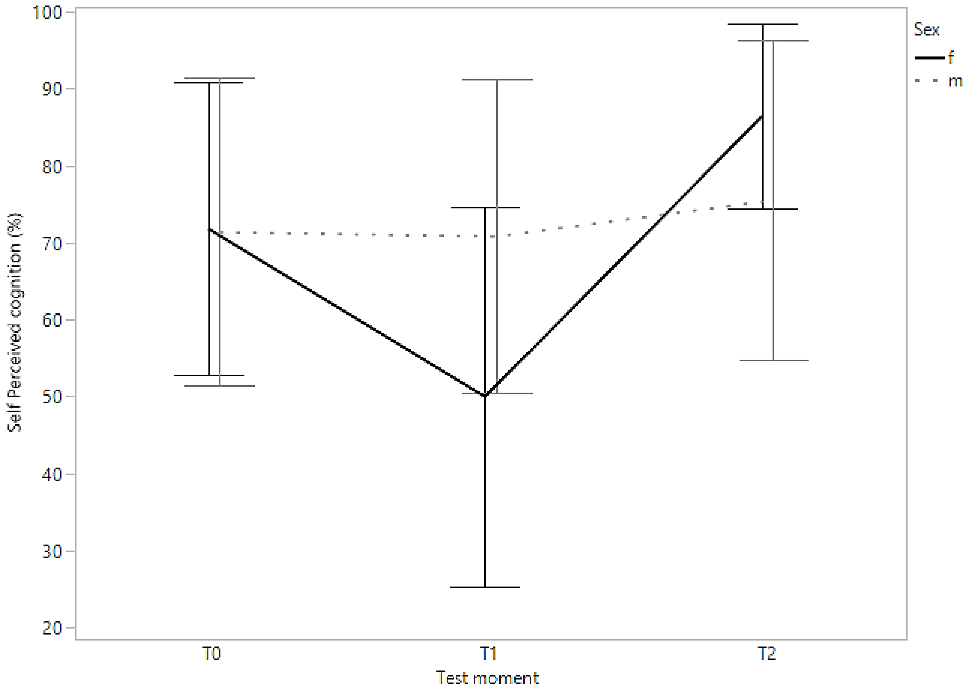
Domain 5 vs. Test Moment, with ADHD Comorbidity Comparison



Note. Domain 5 = sensory orientation of the Kids-BESTest; ADHD = Attention Deficit Hyperactivity Disorder; T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Appendix 12

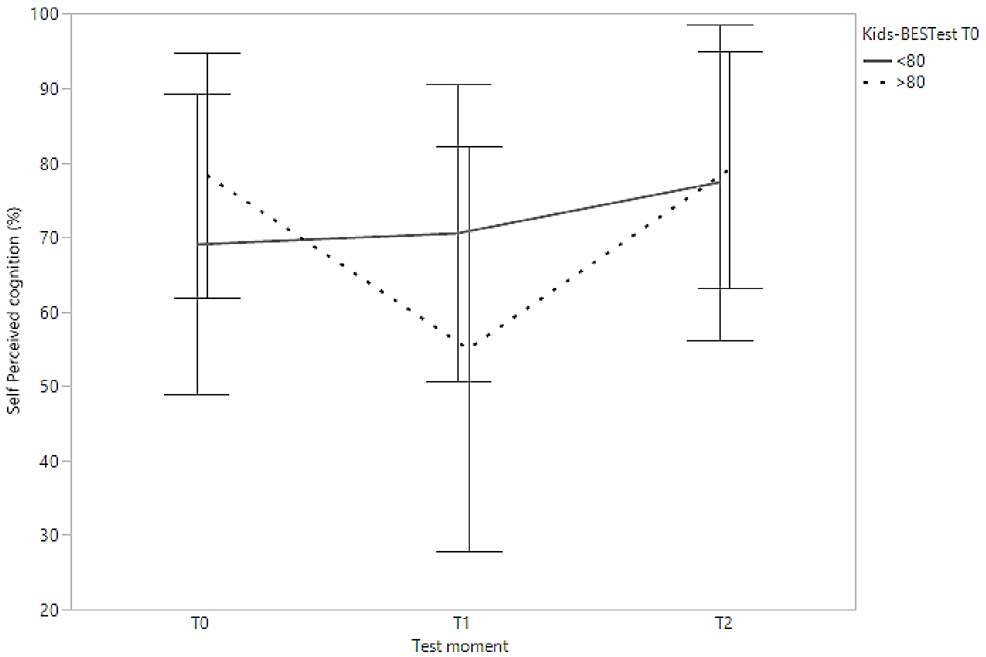
Self Perceived Competence (Cognition) vs. Test Moment, with Sex Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; f = female; m = male.

Appendix 13

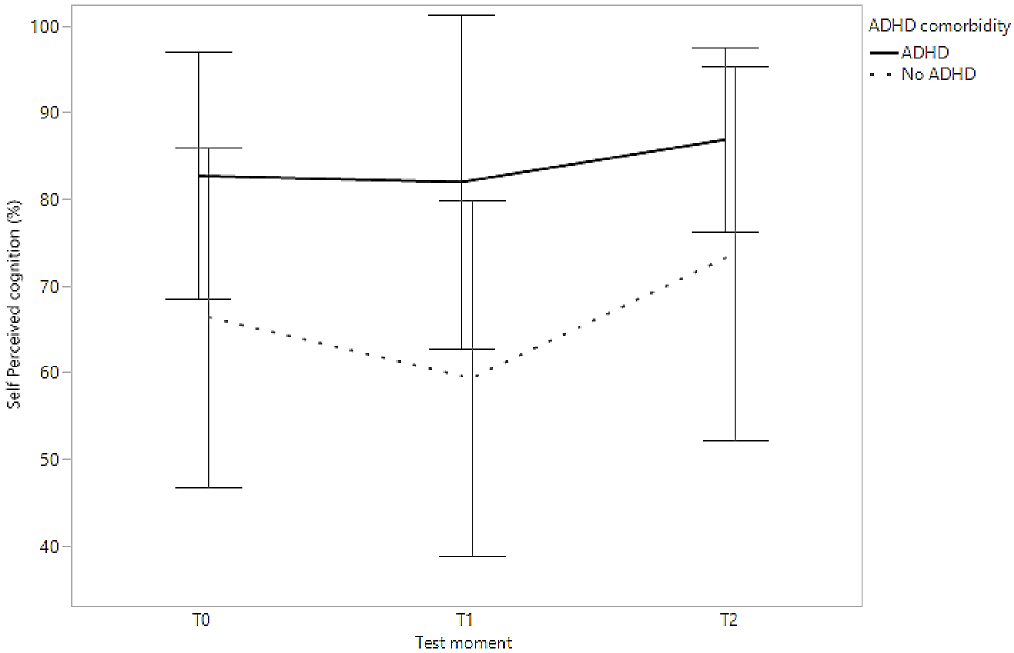
Self Perceived Competence (Cognition) vs. Test Moment, with Kids-BESTest score at T0 Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Appendix 14

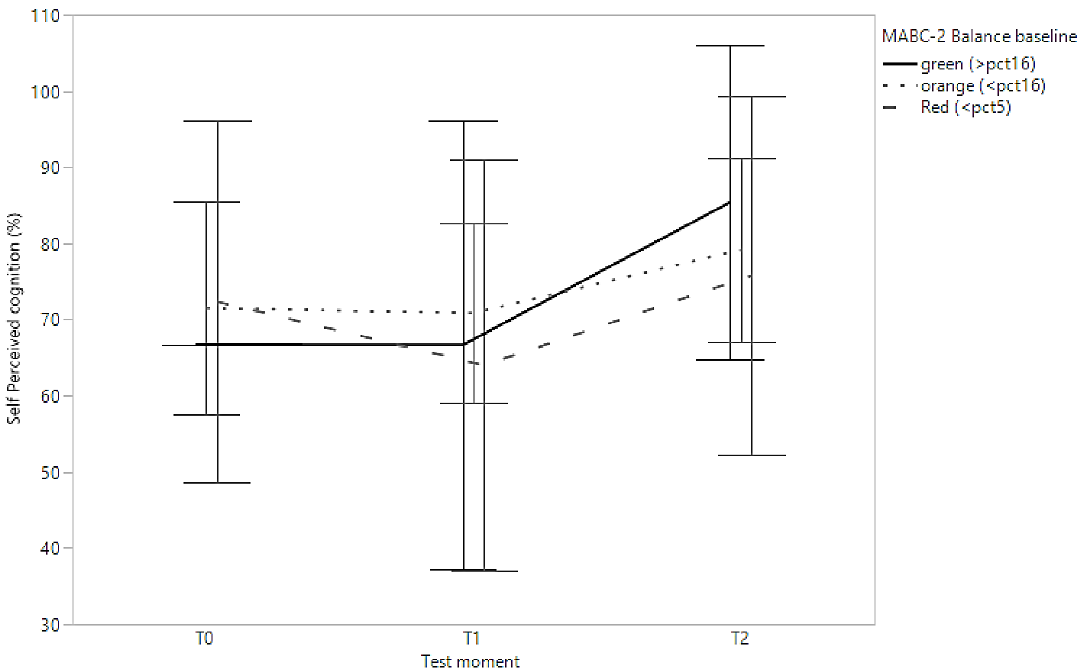
Self Perceived Competence (Cognition) vs. Test Moment, with ADHD comorbidity Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; ADHD = Attention Deficit Hyperactivity Disorder.

Appendix 15

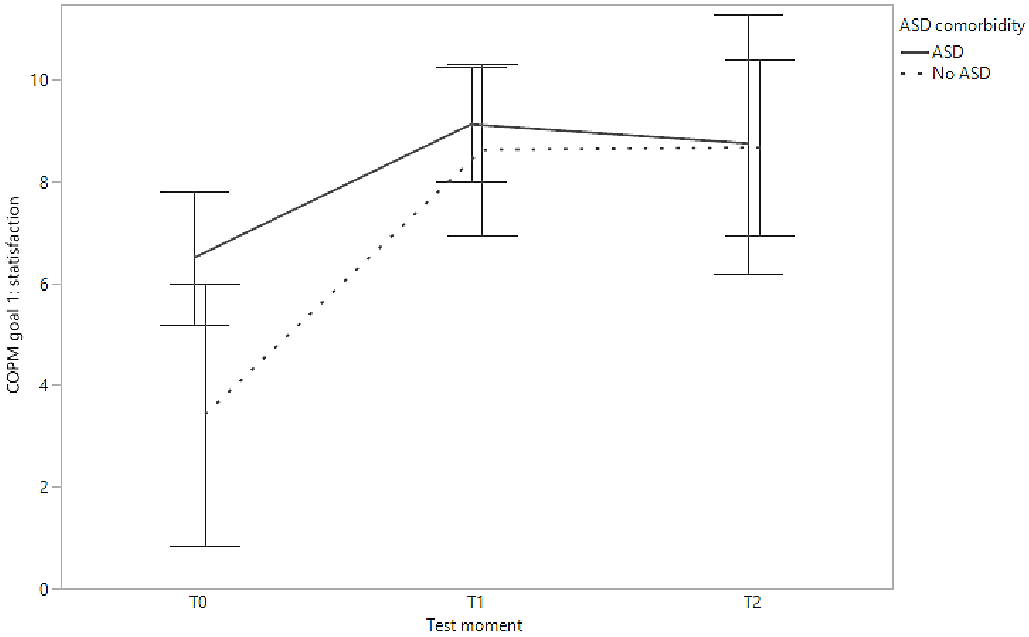
Self Perceived Competence (Cognition) vs. Test Moment, with MABC-2 Balance Baseline score Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Appendix 16

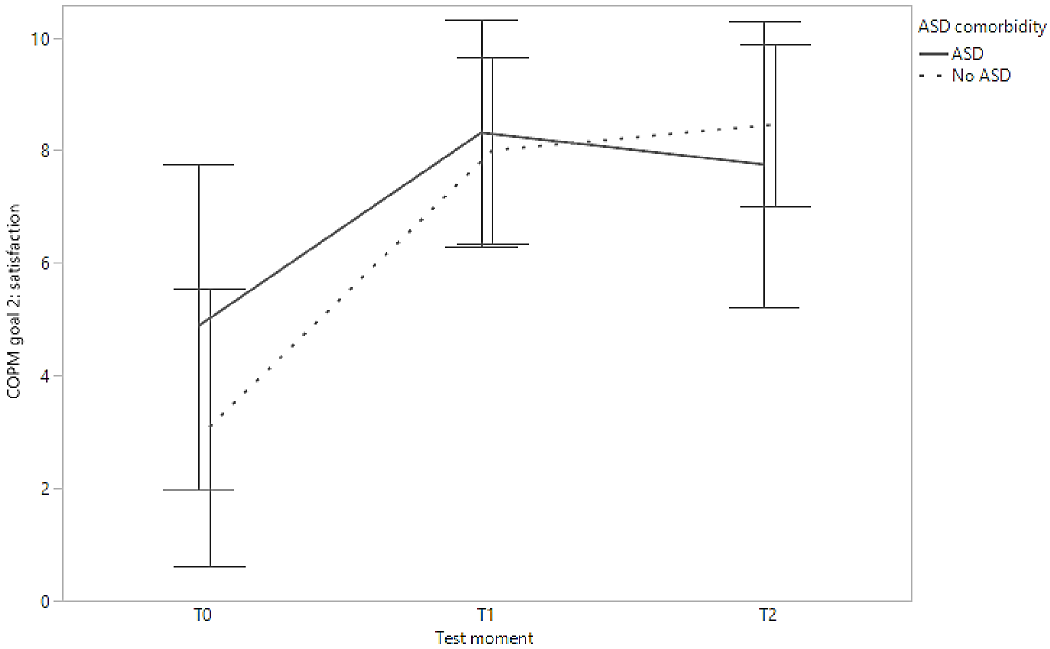
COPM Goal 1 (Satisfaction) vs. Test Moment, with ASD comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; ASD = Autism Spectrum Disorder.

Appendix 17

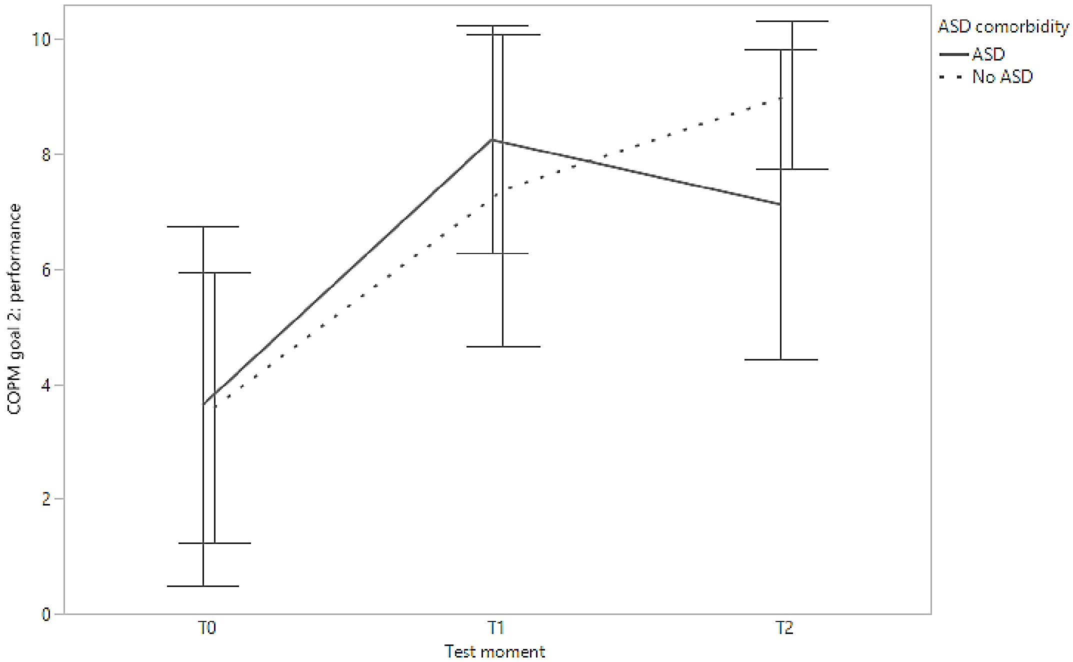
COPM Goal 2 (Satisfaction) vs. Test Moment, with ASD comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; ASD = Autism Spectrum Disorder.

Appendix 18

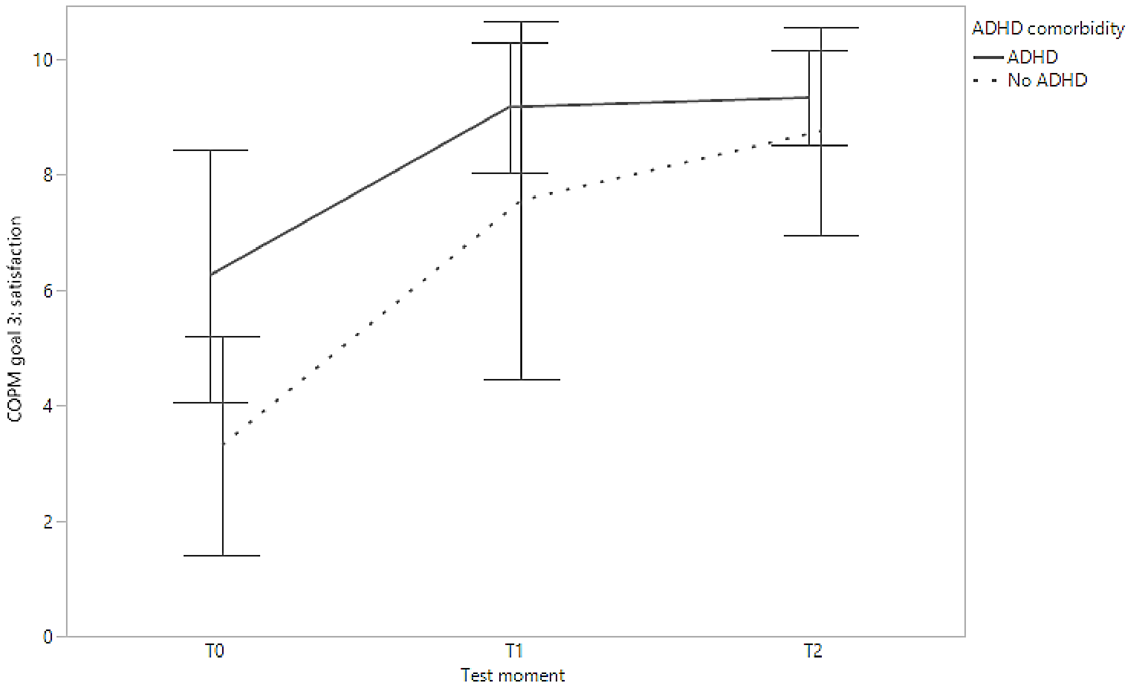
COPM Goal 2 (Performance) vs. Test Moment, with ASD comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; ASD = Autism Spectrum Disorder.

Appendix 19

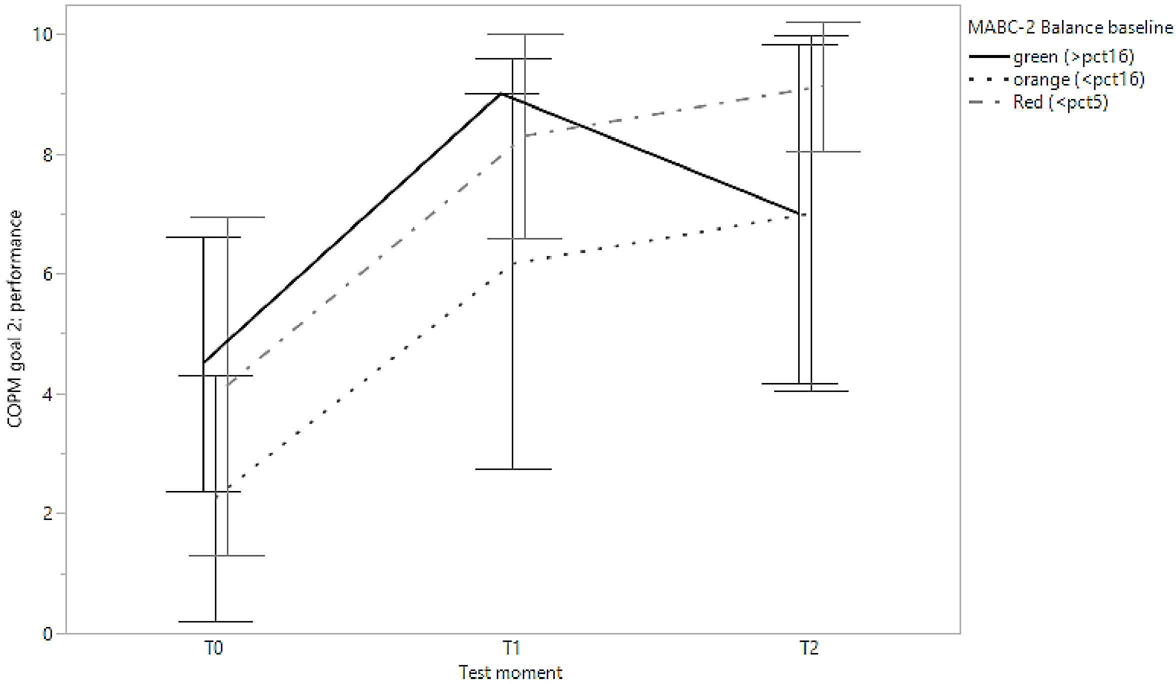
COPM Goal 3 (Satisfaction) vs. Test Moment, with ADHD comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; ADHD = Attention Deficit Hyperactivity Disorder.

Appendix 20

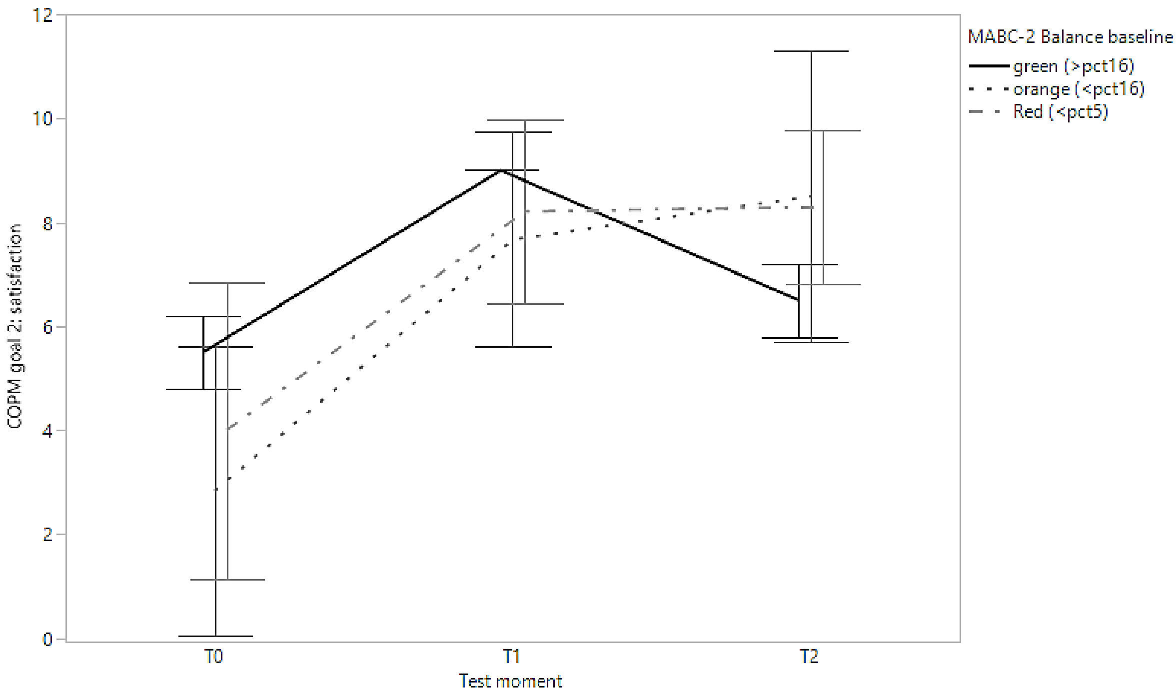
COPM Goal 2 (Performance) vs. Test Moment, with MABC-2 Balance Baseline Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Appendix 21

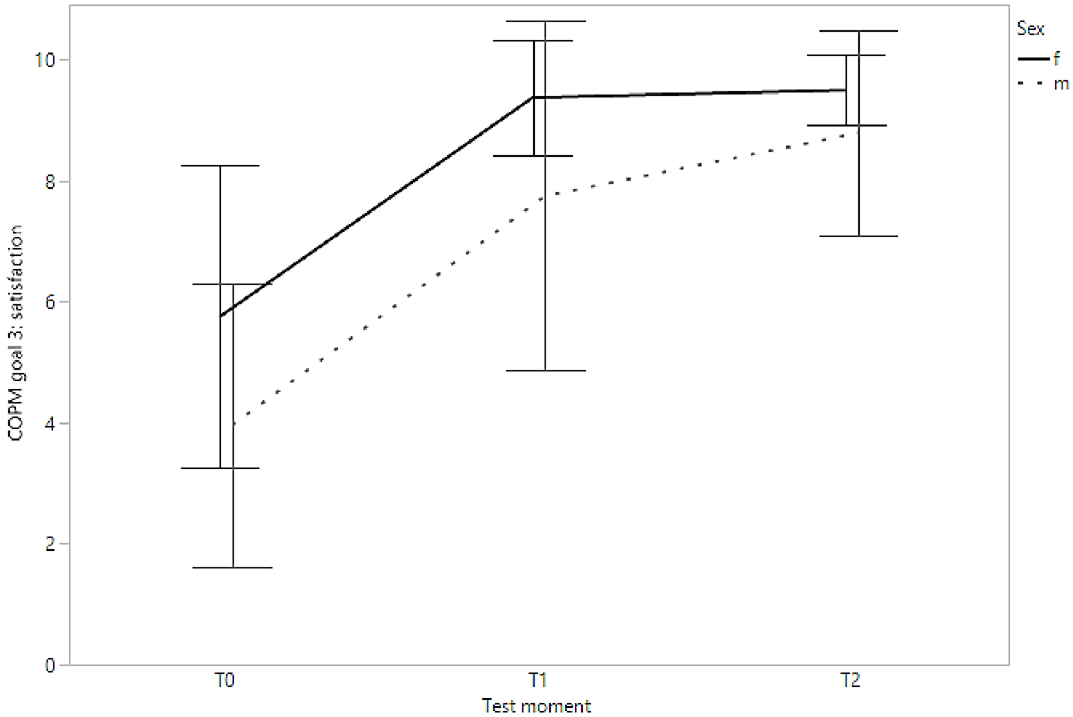
COPM Goal 2 (Satisfaction) vs. Test Moment, with MABC-2 Balance Baseline Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp.

Appendix 22

COPM Goal 3 (Satisfaction) vs. Test Moment, with Sex Comparison



Note. T0 = test moment right before camp; T1 = test moment right after camp; T2 = test moment 3 months after camp; f = female; m = male.