ORIGINAL ARTICLE

# Evaluating intervention using time aids in children with disabilities

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**Abstract**

*Objective:* The aim of this study was to evaluate complex intervention using time aids for children with intellectual and developmental disabilities who exhibit limitations in daily time management. *Methods:* Participating children ($n$ = 47) (F17/M30) were aged 6–11 with ADHD, autism spectrum disorders, mild or moderate intellectual disability, spina bifida, and cerebral palsy. This study used a Randomized Block and Waiting List control group design, with 25 children allocated to control and 22 to intervention group. In total 10 children (21.3%), five from each group, dropped out, leaving 37 children in the data analysis. *Results:* Children in both groups gained significantly in time-processing ability between the first and second data collection, but the children in the intervention group improved time-processing ability significantly more than controls. The control group also displayed significant changes after receiving intervention between the second and third data collection. The intervention had a large effect (ES Cohen's $d = 0.81$) on time-processing ability and a medium effect (ES Cohen's $d = 0.68$) on managing one's time. *Conclusions:* This study provides preliminary evidence that time-processing ability and managing one's time can be improved by intervention using time aids in children with intellectual and developmental disabilities, supporting the need to consider time aids in intervention in these children.

**Key words:** *assistive devices, child, intervention, time management, time perception*

## Introduction

In today's time-dependent society, children with difficulties in managing time in everyday life are at risk of delayed development of time-processing skills compared with their same-aged peers. Children with autism spectrum disorders (ASD) and children with attention deficit hyperactivity disorder (ADHD) have been reported to exhibit problems in time perception/time sense as compared with typically developing children (1,2). Children and adolescents with ASD were found to have difficulties in sequencing events (3). Persons with intellectual disabilities (ID) have demonstrated problems in time orientation (4,5). Impaired executive planning functions, including time management, were found in young people with autism (6) and have been reported in children with ADHD (7,8). In a study by Abikoff et al. (9), most of the children (61%) remained impaired in organizational skills, time management, and planning, in spite of effective stimulant treatment of ADHD symptoms, thus indicating the need for other treatment to target these deficits.

The various concepts of time described above are all defined in the International Classification of Functioning, Disability and Health, Children & Youth version (ICF-CY) (10). Experience of time (b1802), time orientation (b1140) and time management (b1642) are all defined in Part 1 (the domain of Body functions), Chapter 1 (Mental functions). Also in Part 1 (the domain of Activities and participation), Chapter 2 (General tasks and demands) the concept

of Managing one's time (d2305) is defined as managing the time required to complete usual or specific activities, such as preparing to depart from the home and accessing assistive technology and supports in daily life. The mental function of time management (ICF-CY, b1642) is defined as ordering events in chronological sequence, allocating amounts of time to events and activities, as distinct from "managing one's time" in daily life.

*Interventions to support difficulties in managing time*

Occupational therapy intervention in general can be classified into three types/foci: remediation, advocacy, and compensation (11). Remediation of organizational skills and time management and planning is efficient in improving managing one's time in daily life for children with ADHD, and seems to affect academic functioning (7,12).

Advocacy, i.e. support in the social context, is an important factor for successful usage of assistive devices in all ages (13,14). In school, assistive devices need to be integrated into educational practice, and support should help the child to experience immediate benefits from the device and to remove or minimize barriers to social participation (14). Positive attitudes and a desire to provide increased control and independence should always accompany the prescription of assistive devices (5,15). Negative attitudes towards the use of cognitive assistive devices from the person or the social context are related to non-use and participation restrictions (16).

Compensation refers to efforts aimed at negotiating a problem by the use of alternative strategies, modification of methods, or the application of assistive devices such as time aids. At the level of time perception, only one article was found which evaluated the use of time aids. The article indicated that the use of a Time timer to make time visible could improve appropriate waiting behaviour in a child with developmental disabilities (17). Intervention with pictures, presenting daily activities ordered by time, in the support of children with autism is well established as a means of providing an organized and predictable environment (18) and as compensation for lacking orientation in time. There is strong evidence for the effectiveness of cognitive assistive devices, e.g. reminders, in supporting adults to manage their time in daily routines and in employment (19,20). Also the level of participation in everyday activities increases when adults with ID use cognitive assistive devices for managing time and for initiating and terminating activities independently (16).

In ICF-CY, assistive devices are categorized as an environmental factor (WHO 2007). Prescribing and supporting the use of assistive devices is an intervention frequently used by occupational therapists (OT) to increase participation in children with disabilities (14). However, the non-use of assistive devices in general is estimated to be between 30% and 50% (21). A recent study of children with physical disabilities in mainstream schools indicates similar proportions in children's use of time aids (14). This issue is not merely economic but also an indication of the need for improved methods for intervention to support managing one's time.

There is evidence supporting the hypothesis that time perception, time orientation, and time management can be seen as one construct, operationalized as different levels of complexity in time-processing ability (22-25). Perceiving time and knowing the duration of activities is a low level of time-processing ability and is needed to be able to acquire next level: time orientation. Both lower levels are needed to learn the highest level: time management (25). There is also evidence to support the relation of time-processing ability to everyday functioning including managing one's time (23,26).

Thus, much is known about remediation and compensation at the level of higher cognitive functions and of managing one's time. However, there are no outcome studies evaluating the effects of time aids on time-processing ability and managing one's time for children and youth with intellectual and developmental disabilities.

## Aims

The aim of this study was to evaluate intervention using time aids in children with developmental and intellectual disabilities from two aspects of their functioning: time-processing ability and managing one's time.

## Materials and methods

*Study design*

A waiting list design was chosen, in order to provide all clients with time aids interventions over time (27). Because extensive data collection was required, a Randomized Block Design (28) was used.

*Participants*

The participants in the study were children aged 6–11 with ADHD ($n$ = 5), ASD ($n$ = 7), ID ($n$ = 16), physical disability including CP and spina bifida ($n$ = 17), and double diagnosis ($n$ = 2), in total $n$ = 47 children. Children were included with ADHD with no medication or stable medication treatment. Twenty-five children (52.2%) were allocated to the

Table I. Frequency, gender, and age of all participants ($n = 47$) and of participants in analysis ($n = 37$), allocated to intervention group and control group.

| | | | | Gender | | Age |
|---|---|---|---|---|---|---|
| | | Included *n* (%) | In analysis *n* (%) | F (%) | M (%) | M (SD) |
| Valid | Intervention | 22 (47.8) | 17 (45.9) | 6 (35) | 11 (65) | 8.94 (1.35) |
| | Control | 25 (52.2) | 20 (54.1) | 6 (30) | 14 (70) | 8.25 (1.61) |
| | Total | 47 (100) | 37 (100) | 12 (32) | 25 (68) | 8.57 (1.52) |

control group and 22 children (47.8%) to the intervention group. All included participants are presented in Table I according to age and gender.

### *Attrition*

Five families with a child allocated to the control group dropped out (20%) for documented reasons (see Figure 1) leaving 20 children in the control group for the first analysis. All of them participated in step two, receiving intervention using time aids. Five of the children/families allocated to the intervention group dropped out, leaving 17 children in the intervention group for analysis.

The flow chart (Figure 1) presents the allocation of participants, attrition, and remaining participants in analysis.

### *Instruments*

The instrument KaTid-Child (Swedish: Kit for assessing Time-processing ability in children) was created to measure time perception/experience of time, time orientation, and time management (i.e. time-processing ability) and was used for primary outcome. The instrument was used according to the manual. It is a table-top test, where a professional asks the questions and the child can answer verbally or by pointing at a picture. It contains 51 items measuring time perception, time orientation, and time management, summarized into one measure of time-processing ability (22,23). The KaTid has demonstrated evidence of validity and reliability in a number of research studies with children and youth, with and without intellectual and developmental disabilities (22,23,25).

The instrument *Time-Parent scale* was used to evaluate the parent-rated change of managing one's time in daily life. It was created by the first author and a colleague. It includes 13 statements and has a Likert agreement scale with four agreement response alternatives. This scale was found to be psychometrically sound, including internal consistency ( = 0.79–0.86) for children and youth with and without intellectual and developmental disabilities (22,23).

Data collection and delivery of treatment, type, and date were documented by the trained professional in a study-specific protocol. Information on whether intervention was given according to agreement was collected from Time-Parent scale, from the child by means of a checklist, and from the teacher in a study-specific scale. In this study, only data from KaTid-Child, the Time-Parent scale, and information on fidelity will be presented (29).

### *Procedures*

Professionals with experience of intervention with time aids working at habilitation centres in Sweden were invited to training. The professionals, 22 OTs and one special teacher, all attended a two-day course aimed to equip them with the skills needed to perform the assessments and be interventionists in the study. They were also invited to training sessions during the study to minimize "drift" in provider skills. Children were recruited by the professionals among those enrolled for intervention with time aids within a given time period (1 January 2004 to 31 January 2007). Sixty-six children/families were invited to participate, but 19 declined or were excluded. Group allocation was blinded to the professional and randomized. If the professional had two children included, the first child mentioned in the mail from the OT would be randomly allocated to one group and the second would be blocked to the other group. Thus, the blocking variable was the interventionist. If there were two children in the same class, e.g. twins, only one of them was included in the study. The enrolment continued until all 47 children were assigned. A first assessment (t1) was done initially for all participants, typically at the habilitation centre. Intervention was implemented in the experimental group directly after assessment and lasted for a period of six months, followed by a second assessment (t2). Waiting list time was set to six months. The second

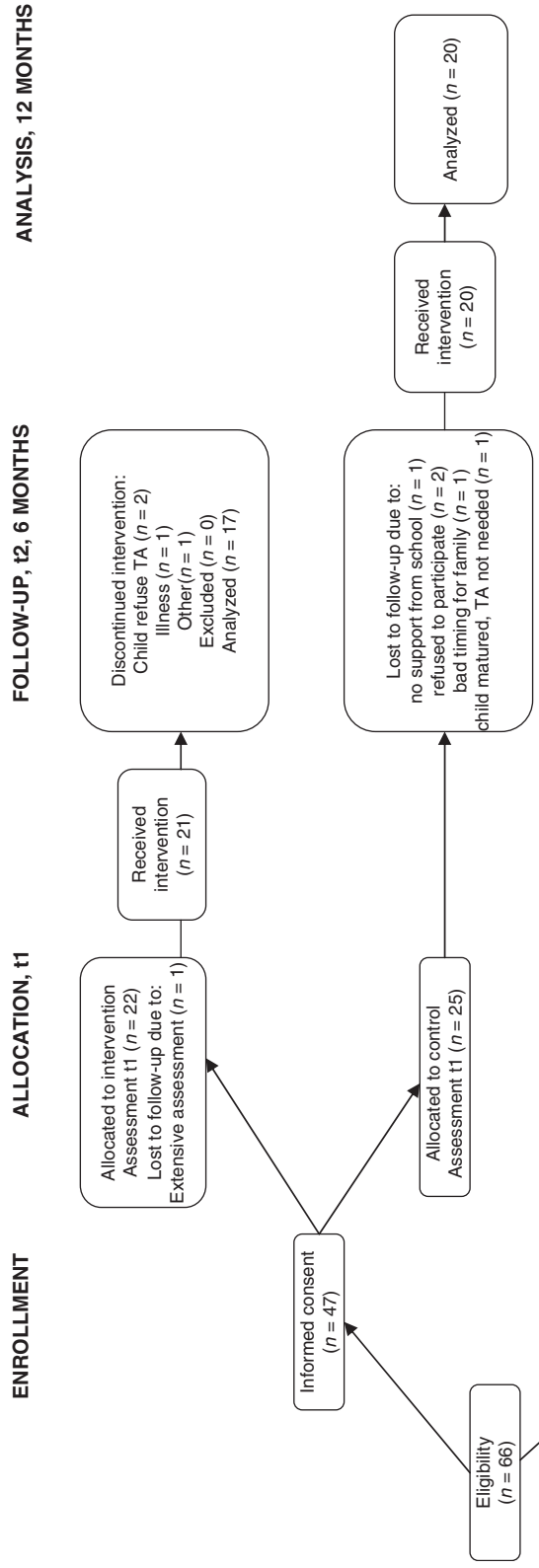


Figure 1. Flow chart of the process of the study.

assessment (t2) was done before the control group had intervention and was followed by a third data assessment (t3) (see Figure 1). All material was coded before being sent to the author.

*Intervention*

The interventions were individually designed and aimed to offer the use of compensation (time aids) and advocacy (education to context(s) and adaptations in school), integrating most of the intervention in the everyday context of the individual (5,14-16). The education recommended was to impart knowledge on time-processing ability and managing one's time to parents and teachers/assistants on at least one occasion, in a group or individually. The professional documented when and to whom education was given.

Time aids used to compensate lacking *time perception* are devices making the passage of time visible and understandable. One example is the Time rule with a row of light diodes, where many lit diodes indicate a long time and few indicate a short time (5). Intervention to support *time orientation* includes schedules, the quarter-hour watch, adapted calendars, and other visual aids to promote orientation in the time of day, week, or year. Interventions to promote, develop, and/or compensate for deficits in *time management* are about self-scheduling skills, using an adapted Filofax or adaptable software in a personal digital assistant (PDA) such as Handi. The process of prescribing time aids included a set of meetings documented in an intervention protocol. The child and family made a verbal agreement with the professional on how service should be delivered, in what daily situations a device would be used, etc.

All children with intellectual or developmental disabilities in the intervention group received at least one time aid. The single most prescribed time aid was the Time rule, often in combination with an intervention on a higher level of time-processing ability, e.g. calendars for orientation in time. If more than one time aid was prescribed, the time aid at the highest level of time-processing ability is presented. The type of intervention, the frequency, and use of time aids given to the intervention group ($n = 17$) and to the control group during their intervention ($n = 18$) are presented in Table II.

Children in the control group ($n = 20$) received treatment as usual during their waiting-list time (t1–t2). During intervention (t2–t3) they received the same intervention using time aids as had been offered to the intervention group. In the control group also the single most prescribed time aid was a Time rule.

In total, for all children receiving intervention ($n = 37$), education was given in eight cases in one context and in 17 cases in two or more contexts (including the school, and two homes if the parents were separated). The intervention of time aids, including education, contained 3–11 (mean 5.6) meetings with the professional of $1^1/_2$–2 hours' duration, as well as 3–5 occasions for assessment.

*Data analysis*

Initially, the raw scores from the KaTid-Child and Time-Parent scale were all analysed using a Rasch model (30). This process has been described in detail elsewhere (31). This analysis generated individual measures of time-processing ability and managing one's time. Descriptive statistical analysis was then conducted on the demographic and intervention components. Analyses compared the groups to detect any significant pre-intervention differences between the control group ($n = 20$) and the intervention group ($n = 17$). Data on fidelity were reported; if intervention was given as agreed, as rated by child, parent, professional, and teacher. A paired *t*-test was performed to compare the change in time-processing ability of the control group during their waiting-list period with the change during intervention.

To evaluate the difference between the control group during waiting time and the intervention group, an independent samples *t*-test was performed using SPSS (32). Cohen's *d* effect size (ES) was also used to analyse the magnitude of the difference in time-processing ability and managing one's time between groups after intervention/waiting. Expressed in Cohen's *d*, effect-sizes $d > 0.2$–$0.5$ are considered small, $d > 0.5$–$0.8$ medium and $d > 0.8$ are considered large (33).

## Results

There were no significant differences between attrition and participants. Analyses were also conducted to confirm whether the two groups were equivalent before the start of the intervention. No significant differences between the control group ($n = 20$) and the intervention group ($n = 17$) were found in age ($p = 0.26$), gender ($p = 0.59$), or diagnosis ($p = 0.93$). The analysis of pre-intervention data from KaTid-Child ($p = 0.92$) and the Time-Parent scale ($p = 0.28$) proved no significant differences. The level of time-processing ability pre-intervention was also similar between the groups (see Table II).

*Fidelity*

A specific enquiry regading to what extent intervention had been given was made in the intervention group. Thirteen of the 15 responding children stated that the time aid had been introduced as agreed. Most of the parents, teachers, and professionals stated that the

Table II. Pre-intervention level of time-processing ability, type of intervention given to the intervention group ($n = 17$) and type given to the control group ($n = 18$) during intervention.

| | | Group | | |
|---|---|---|---|---|
| | | Intervention | Control | Total |
| Pre-intervention level of time-processing ability | KaTid raw score 0–15 | 3 | 4 | 7 |
| | KaTid raw score 16–48 | 10 | 11 | 21 |
| | KaTid raw score 49–63 | 4 | 3 | 7 |
| Education to context | No education given | 5 | 4 | 9 |
| | To one context | 4 | 4 | 8 |
| | To two or more contexts | 8 | 9 | 17 |
| Use of ordinary time aids, e.g. wristwatch, alarm clock | Do not use | 2 | 1 | 3 |
| | Use sometimes | 2 | 5 | 7 |
| | Use often | 11 | 10 | 21 |
| Use of special TA[a] | Use TA in one context | 12 | 12 | 24 |
| | Use TA in many contexts | 4 | 6 | 10 |
| Frequency of special TA | One time aid only | 6 | 7 | 13 |
| | Multiple time aids | 11 | 11 | 22 |
| TA for Time perception | Time Ruler etc. | 14 | 17 | 31 |
| TA for orientation in time | Calendar etc. | 10 | 10 | 20 |
| | Quarter-hour-watch | 1 | 1 | 2 |
| TA for time management | Filofax | 4 | 2 | 6 |
| | Handi II | 2 | 1 | 3 |
| Adaptations in school | No adaptations made | 6 | 4 | 10 |
| | Individual **or** for the class | 9 | 9 | 18 |
| | Individual **and** for the class | 1 | 5 | 6 |

Note: [a]TA = Time Aid.

intervention had been given at least partly as agreed; in no case did anyone say that nothing had been done.

*Children in the intervention group changed more than the control group*

The children in both groups showed a significant increase in time-processing ability measured by KaTid-Child during the first period measured (Table III). The intervention group increased significantly more than the control group (Table III). In an independent samples *t*-test, the mean difference in increase was significant ($t = 2.49$, df = 35, sig 2-tailed $p < 0.05$), comparing the increase in time-processing ability in the intervention group during intervention to that in the control group during the waiting list period, effect size (ES) Cohen's $d = 0.81$.

*The effect of intervention on managing one's time*

In the *t*-test of the Time-Parent scale, the intervention group had increased 0.9 logits (SD 0.98) as compared

Table III. KaTid-Child, mean measures in logits of participants in each group at data collection one (t1), two (t2), and three (t3), and difference between groups.

| | t1 (SD) | t2 (SD) | diff t2–t1 | t2 (SD) | t3 (SD) | diff t3–t2 |
|---|---|---|---|---|---|---|
| Intervention group ($n = 17$) | 0.26 (2.13) | 1.62 (2.57) | 1.35** | | | |
| Control Group ($n = 20$) | 0.20 (1.84) | 0.77 (1.70) | 0.58** | 0.77 (1.70) | 1.67 (2.16) | 0.89** |
| Total | | | 0.78* | | | |

Notes: **Sig. (two-tailed) $p < 0.001$. *Sig. (two-tailed) $p < 0.05$.

with the control group's 0.35 logits (SD 0.59), but the difference was not significant ($t$ = 1.96, df = 29, $p$ = 0.06), ES Cohen's $d$ = 0.68.

## Discussion

The aim of this study was to evaluate intervention using time aids in children with developmental and intellectual disabilities. The ES indicates that intervention using time aids could have a large effect on time-processing ability. The results show that children in both groups gained significantly in time-processing ability between the first and second data collection, and children in the intervention group increased significantly more during intervention than children in the control group during the waiting-list time. Also the children in the control group did increase significantly in time-processing ability during intervention (t2–t3) (see Table III). The ES on managing one's time measured by the Time-Parent scale was medium.

A conclusion from these results is that intervention with advocacy, combined with compensation using time aids, may increase the pace of development of time-processing ability, including time management. Thus, providing time aids is not merely a compensatory intervention – it can also be considered as a remediating intervention for cognitive time-processing ability. This is in line with other studies indicating that computerized training in children with disabilities might improve cognitive functioning (34,35). Cognitive assistive devices have previously been considered as compensatory, i.e. assistive devices compensate for lacking cognitive abilities in daily situations once the child learns how to handle the device. It is not expected or established that using assistive devices can also increase cognitive abilities in children with disabilities. It may be that active engagement and control over events in everyday life affect cognitive functions, as indicated in a study by Nilsson (36). Training self-initiated movement by using a powered wheelchair facilitated wakefulness, alertness, initiative, and exploratory behaviour in children with profound cognitive disabilities, as well as showing maturational effects.

The results on the Time-Parent scale showing medium effect on managing one's time, (ES Cohen's $d$ = 0.68), are in line with the findings of Gillespie et al., that cognitive assistive devices are efficient in compensating for time management and in improving managing one's time (ICF-CY d2305) in daily routines in adults. Thus, effects from time-processing intervention can be seen not only on the level of body functions but also in the domain of activity and participation. Owen (4) suggested that it might be possible to facilitate the development of time perception and time orientation. This study shows that this is so, as well as that intervention using time aids facilitates development of time management and managing one's time in daily life. Further research could focus on whether intervention might also reduce feelings of powerlessness and increase feelings of self-efficacy, as suggested (ibid.).

The KaTid is based on measuring a construct with concepts identified in ICF-CY (10). This is an attempt to support intervention by the use of unifying concepts in assessment and in interventions, allowing different contexts, e.g. home and school, to communicate goals and intervention. Simeonsson et al. (37) identified the use of unified concepts as a factor that might affect the efficiency of intervention. It might also facilitate investigations of the external validity of results by providing a common language for describing characteristics of children within diagnostic groups. Even though few children with ADHD were included in the current study ($n$ = 5), the results provide preliminary indications that interventions using time aids can also have effects for this group of children.

The design with a control group not only indicated intervention effects but also indicated that time-processing ability is related to maturation, as participating children changed significantly in time-processing ability during their waiting-list period. This is expected in typically developing children (38) but children with intellectual and developmental disabilities also develop cognitive functions over time, though often at a slower pace (39). Also the findings in this study are in accordance with results in an earlier study indicating a relation between time-processing ability and age in children with intellectual and developmental disabilities (24). The development of a child is the product of an ongoing dynamic process with a mutual transaction between the child and his/her social context, often leading to an individual developmental variability (40).

In this sample there is a wide range in the increase in time-processing ability within the group: some of the children in the control group show no change at all; a few others increase to the same extent as children in the intervention group. This may be explained by education as part of intervention. The parents of two children in the control group received education in advance and those children increased in time-processing ability more than expected. This indicates that education might play an important role in time-processing intervention. It underlines the recommendation to include education when prescribing assistive devices (5,15,16). It is also in line with increasing evidence that parent training may have an effect not only on parental stress but also on the child's behaviour – but a lesser effect on cognitive functions (41) in the form used thus far. Future research might reveal whether parent training in time-processing ability could be considered complementary when aiming at improved managing one's time for children.

Another possible explanation is testing – the assessment itself may have aroused an interest in processing and managing time. Professionals using the instrument KaTid affirm that some parents comment that the child asked questions not heard earlier, associated with items in KaTid, after the assessment was done.

The lack of support from school was reported as a main reason for at least one participant in terminating participation in the study. Copley and Ziviani (42) pointed out the lack of suitable information provision and training of school personnel as a barrier to the use of assistive technology. Also a lack of organizational support for professional cooperation between teachers and therapists has been identified, resulting in limited participatory arrangements using assistive devices in children with disabilities (43). The results of this study strengthen this previously expressed need for the improvement of inter-agency cooperation between healthcare and education.

### *Methodological limitations*

The dropouts present a possible bias since they might differ from the participants following the full intervention and, if exceeding 20%, bias might be a concern (28). Of the 47 participants included, 10 children (21%), dropped out. The longitudinal design tends to produce higher rates of attrition (ibid.). It is notable that the dropouts had documented reasons, that they were the same number in each group, and that no significant differences were detected between them and the participants in analysis.

Intervention prescribing time aids is still fairly new, especially at lower levels of time-processing ability. Routines and knowledge were developed in the process of this study indicating the possibility for improved results in future studies.

The evaluation of the effects of intervention was in this study performed with KaTid-Child, and the Time-Parent scale, which have not earlier been used to evaluate change over time. This study adds to the body of evidence that the KaTid-Child can measure change over time and can capture an effect of intervention in children with intellectual and developmental disabilities.

It is not known why the outcome of managing one's time, as rated by the parents, was not significant, and yet generated an ES of medium size (Cohen's $d = 0.68$). It can be noted that the difference was close-to significant ($p = 0.06$), and possibly the small sample size and large variability could explain the difference. There is some discussion about relying purely on statistical significance; in data with increased variability the use of ES might lead to a stronger measure of effect, better reflecting clinical needs (44). With this in mind, the results seem to indicate that intervention using time aids can also improve managing one's time in everyday life. It is also reasonable to consider that managing one's time, as rated by the parents, is of greater use in clinical settings since it reflects everyday functioning better than a standardized instrument measuring time-processing ability. Further studies using larger samples will support or refute such assumptions.

This study included a small number of participants and since this might affect generalizability the results should be interpreted with caution.

## Clinical implications

This study supports the idea that prescription of assistive devices needs to be an integrated part of the intervention given to compensate for a child's disability (45). It adds that intervention using time aids might also improve cognitive functions such as time-processing ability.

This implies that occupational therapists and other professionals should be aware of and provide support when needed to children with intellectual or developmental disabilities who could be at risk of delayed time management and limitations in managing their time.

There is a need for occupational therapists to acquire new knowledge in the area in order to be able to suggest time aids appropriate to the level of time-processing ability and needs of the child in each situation and to support the use of the prescribed device.

Procurement of cognitive assistive devices should include education in the context that includes the cognitive function. Education on lacking time-processing ability and time aids should provide knowledge about managing one's time.

### *Conclusions and further research*

This study provides evidence that time-processing ability can be improved by intervention using time aids in children with intellectual and developmental disabilities. While the results show significant differences in favour of the intervention group, also confirmed by ES, the study needs further replication to ensure consistency of the findings.

To improve managing one's time in children with developmental and intellectual disabilities, methods in intervention need further improvement and the inclusion of all contexts in which the child is active.

There is also a need for research to investigate whether intervention using time aids could be considered a non-pharmaceutical complement to medical treatment in children with ADHD. Research might also investigate if intervention supporting managing

one's time might reduce feelings of powerlessness and increase self-efficacy and participation.

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## References

1. Szelag E, Kowalska J, Galkowski T, Poppel E. Temporal processing deficits in high– functioning children with autism. Br J Psychol 2004;95:269–82.
2. Smith A, Taylor E, Rogers JW, Newman S, Rubia K. Evidence for a pure time perception deficit in children with ADHD. J Child Psychol Psychiatry 2002;43:529–42.
3. Boucher J, Pons F, Lind S, Williams D. Temporal cognition in children with autistic spectrum disorders: Tests of diachronic thinking. J Autism Dev Disord 2007;37:1413–29.
4. Owen AL, Wilson RR. Unlocking the riddle of time in learning disability. J Intellect Disabil 2006;10:9–17.
5. Arvidsson G, Jonsson H. The impact of time aids on independence and autonomy in adults with developmental disabilities. Occup Ther Int 2006;13:160–75.
6. Hughes C, Russel J, Robbins TW. Evidence for executive dysfunctioning in autism. Neuropsychologia 1994;32: 477–92.
7. Abikoff H, Gallagher R, Wells KC, Murray DW, Huang L, Lu F, et al. Remediating organizational functioning in children with ADHD: Immediate and long-term effects from a randomized controlled trial. J Consult Clin Psychol 2013;81: 113–28.
8. Barkley RA. Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. Psychol Bull 1997;121:65–94.
9. Abikoff H, Nissley-Tsiopinis J, Gallagher R, Zambenedetti M, Seyffert M, Boorady R, et al. Effects of MPH-OROS on the organizational, time management, and planning behaviors of children with ADHD. J Am Acad Child Adolesc Psychiatry 2009;48:166–75.
10. WHO. International Classification of Functioning, Disability and Health, Children & Youth version (ICF-CY). Geneva: World Health Organization; 2007.
11. McColl MA. Introduction: A basis for theory in occupational therapy. In McColl MA, editor. Theoretical basis of occupational therapy. 2nd ed. Thorofare, NJ: SLACK; 2003. p 191.
12. Langberg JM, Epstein JN, Urbanowicz CM, Simon JO, Graham AJ. Efficacy of an organizational skills intervention to improve the academic functioning of students with attention deficit/hyperactivity disorder. Sch Psychol Q 2008;23: 407–17.
13. Riemer-Reiss M, Wacker RR. Assistive Technology Discontinuance Technology and Persons with Disabilities Conference, California State University. csun.edu; 2000.
14. Hemmingsson H, Lidström H, Nygård L. Use of assistive technology devices in mainstream schools: Students' perspective. Am J Occup Ther 2009;63:463–72.
15. Granlund M, Bond A, Lindstöm E, Wennberg B. Assistive technology for cognitive disability. Technol Disabil 1995;4: 205–14.
16. Wennberg B, Kjellberg A. Participation when using cognitive assistive devices – from the perspective of people with intellectual disabilities. Occup Ther Int 2010;17:168–76.
17. Grey I, Healy O, Leader G, Hayes D. Using a Time Timer™ to increase appropriate waiting behaviour in a child with developmental disabilities. Res Dev Disabil 2009;30:359–66.
18. Pierce KL, Schreibman L. Teaching daily living skills to children with autism in unsupervised settings through pictorial self-management. J Appl Behav Anal 1994;27:471–81.
19. Gillespie A, Best C, O'Neill B. Cognitive function and assistive technology for cognition: A systematic review. J Int Neuropsychol Soc 2012;18:1–19.
20. Lindstedt H, Umb-Carlsson Ö. Cognitive assistive technology and professional support in everyday life for adults with ADHD. Disabil Rehabil Assist Technol 2013;8:402–8.
21. Wessels R, Dijcks B, Soede M, Gelderblom GJ, De Witte LP. Non-use of provided assistive technology devices, a literature overview. Technol Disabil 2003;15:231–8.
22. Janeslätt G, Granlund M, Alderman I, Kottorp A. Development of a new assessment of time processing ability in children, using Rasch analysis. Child Care Health Dev 2008;34: 771–80.
23. Janeslätt G, Granlund M, Kottorp A. Measurement of time processing ability and daily time management in children with disabilities. Disabil Health J 2009;2:15–19.
24. Janeslätt G, Granlund M, Kottorp A, Almqvist L. Patterns of time processing ability in children with and without developmental disabilities. J Appl Res Intellect Disabil 2010;23: 250–62.
25. Janeslätt G. Validity in assessing time processing ability, test equating of KaTid-Child and KaTid-Youth. Child Care Health Dev 2012;38:371–8.
26. Donlau M, Imms C, Glad Mattsson G, Mattsson S, Sjörs A, Falkmer T. Children and youth with myelomeningocele's independence in managing clean intermittent catheterization in familiar settings. Acta Paediatr 2011;100:429–38.
27. Kazdin AE. Research design in clinical psychology. 4th ed. Boston: Allyn & Bacon; 2002.
28. Polit DF, Beck CT. Nursing research: Principles and methods. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2004.
29. Bellg AJ, Borrelli B, Resnick B, Hecht J, Minicucci DS, Ory M, et al. Enhancing treatment fidelity in health behavior change studies: Best practices and recommendations from the NIH Behavior Change Consortium. Health Psychol 2004;23: 443–51.
30. Bond TG, Fox CM. Applying the Rasch model: Fundamental measurement in the human sciences. 2nd ed. London: Lawrence Erlbaum; 2007.

31. Fisher AG. The assessment of IADL motor skills: An application of many-faceted Rasch analysis. Am J Occup Ther 1993;47:319–29.
32. SPSS. IBM Statistical Package for the Social Sciences (SPSS) 20.0 for Windows ed. Chicago: SPSS; 2011.
33. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Mahwah, NJ: Lawrence Erlbaum; 1988.
34. Klingberg T, Fernell E, Olesen PJ, Johnson M, Gustafsson P, Dahlström K, et al. Computerized training of working memory in children with ADHD: A randomized, controlled trial. Am J Public Health 2005;44:177–234.
35. Van't Hooft I, Andersson K, Bergman B, Sejersen T, von Wendt L, Bartfai A. Sustained favorable effects of cognitive training in children with acquired brain injuries. NeuroRehabilitation 2007;22:109–16.
36. Nilsson LM, Nyberg PJ. Driving to learn: A new concept for training children with profound cognitive disabilities in a powered wheelchair. Am J Occup Ther 2003;57:229–33.
37. Simeonsson RJ, Scarborough AS, Hebbeler K. ICF and ICD codes provide a standard language of disability in young children. J Clin Epidemiol 2006;59:364–72.
38. Bylholt C. A review of the literature on the acquisition and development of time concepts in children. CAEDHH J/La Revue ACESM 1997;23:119–24.
39. Burack J, Hodapp RM, Ziegler E. editors. Handbook of mental retardation. Cambridge, UK: Cambridge University Press; 1998.
40. Sameroff AJ, Fiese BH. Transactional regulation: The developmental ecology of early intervention. In Meisels S, editor. Handbook of early childhood intervention. 2nd ed. Cambridge: Cambridge University Press; 2000. p 135–59.
41. Kaminski JW, Valle LA, Filene JH, Boyle CL. A meta-analytic review of components associated with parent training program effectiveness. J Abnorm Child Psychol 2008;36:567–89.
42. Copley J, Ziviani J. Barriers to the use of assistive technology for children with multiple disabilities. Occup Ther Int 2004; 11:229–43.
43. Hemmingsson H, Gustavsson A, Townsend E. Students with disabilities participating in mainstream schools: Policies that promote and limit teacher and therapist cooperation. Disabil Soc 2007;22:383–98.
44. Olejnik S, Algina J. Measures of effect size for comparative studies: Applications, interpretations, and limitations. Contemp Educ Psychol 2000;25:241–86.
45. Copley J, Ziviani J. Barriers to the use of assistive technology for children with multiple disabilities. Occup Ther Int 2004; 11:229–43.