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Feasibility of a Tablet-Based Program for Training Everyday Planning in Adolescents With Intellectual Disabilities

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Background: Individuals with intellectual disabilities (ID) show difficulties with everyday planning. A tablet-based training program for everyday planning may be a suitable intervention, but its feasibility must be evaluated. This study evaluated how behavior changes during training and if individuals with ID can use technology by themselves. **Method:** Thirty-three adolescents with ID and 30 younger children with a typical development were recruited. The participants were instructed to train in school for a total of 300 minutes. After the intervention, the participants were matched on mental age (MA). **Results:** Only 16% of the participants trained for all 300 minutes. Participants in the MA group trained for a longer time than the ID group. Both groups made fewer errors per task at the end compared to the beginning. Individuals with ID started off making less attempts per task and increased their activity during the training. This pattern was not seen in the comparison group. **Conclusions:** Both groups used the program independently, without adult supervision. However, a large group of participants in the ID group had a low usage time. Thus, the program might not have been feasible for that subgroup. The ID group increased their activity during the training which might mirror a strategy development of how to use the program. The change in behavior in activity on task attempts can be interpreted such that individuals with ID need a longer time to get familiarized with the technology. Tablet-based training programs are feasible for individuals with ID, but it is necessary to follow up on usage time.

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Planning ability is essential in everyday life. Planning is defined as formulating a set of subgoals to achieve a future goal (Hayes-Roth & Hayes-Roth, 1979; Scholnick & Friedman, 1993). It is employed in both short-term and long-term plans, such as planning the morning routine or the summer's holidays. Individuals with ID show planning difficulties (Danielsson et al., 2012; Danielsson et al., 2010; Van der Molen et al., 2007). Previous research has found that computerized cognitive training can be beneficial for this group (e.g., Lanfranchi et al., 2017; Söderqvist et al., 2012), perhaps can planning ability also be supported by providing a computerized training program. The intervention is feasible if the participants learn to employ the training program. Further, the participants has to carry through the training, thus adherence to training needs to be studied. This study investigated the feasibility of a tablet-based, everyday planning training program and compared adolescents with ID to mental age (MA) matched children with a typical development (TD).

Research has found that planning abilities are affected in individuals with intellectual disabilities (ID). Individuals with ID perform lower than their peers matched on chronological age (Danielsson et al., 2012; Numminen et al., 2001; Van der Molen et al., 2007), and in some studies lower than a MA-matched comparison group (Danielsson et al., 2010). Individuals with ID may be missing a strategy for solving the planning tasks, which might explain the difficulties. Bray et al. (1997) and Poloczek et al. (2016) found that individuals with ID can learn and use strategies, but that they use fewer strategies than their chronological age-matched peers. Thus, introducing an intervention program aimed at training strategies for everyday planning might be beneficial for this population.

For an intervention to be effective, it must be possible to implement in the intervention on the intended population and setting, for example, a school. A feasibility study helps the researchers find possible limitations in a proposed intervention (Bowen et al., 2009). The purpose of a feasibility study is to assess the components of an intervention, including the implementation and adherence to training (Bowen et al., 2009). Feasibility of cognitive training programs is commonly assessed by only evaluating the improvement after the training (e.g., Boot et al., 2018; Lanfranchi et al., 2017; Söderqvist et al., 2012; Stephenson & Limbrick, 2015; Wehmeyer et al., 2004). This assessment limits the important objective of studying how the program is used and how the behavior changes during the training. Perhaps is the program not usable for the population with ID. Research evaluating the feasibility of assistive technology for cognition (ATC), found that ATCs are only being used with adult supervision (Lisa Palmqvist & Danielsson, 2020). The same barrier might be seen when implementing a more complex training program in an intervention study. To our knowledge, no study has yet investigated if this is the case.

Studies have investigated the effectiveness and feasibility of cognitive training programs in individuals with ID (e.g., working memory; WM; Danielsson et al., 2015). Söderqvist et al. (2012) studied the feasibility of cognitive training for WM and nonverbal reasoning in children with ID. The authors found that that the training was feasible for the group as the participants fulfilled the criteria for sessions trained and were able to improve their cognitive performance. Lanfranchi et al. (2017)examined the feasibility of an expert supervised computer-based spatial-simultaneous WM training program for individuals with Down syndrome.

For cognitive training to be beneficial for the participants, the effect should generalize to other, untrained, tasks that the individual encounters in everyday life. However, finding these transfer effects have proven hard (e.g., Melby-Lervåg & Hulme, 2013; Rapport et al., 2013). The literature show that near transfer is more common than far transfer (Gathercole et al., 2012; Simons et al., 2016). That is, the closer the untrained task is to the trained task in terms of shared underlying components, the more likely it is to find a transfer effect (Gathercole et al., 2019). Thus, an effective training program should aim at training the specific components involved in a task where the improvement is desired. Lanfranchi et al. (2017), however, was able to find significant positive effects on the tasks that were similar to what was being trained, but not in the tasks aimed at finding a generalized transfer effect to untrained tasks. The objective of this study was to investigate the feasibility of the training program. Thus, the possible transfer effect to untrained tasks remains to be investigated.

The current study investigated the feasibility of an everyday planning training program. In the program, the planner first identifies subgoals of the plan, then orders the subgoals in the appropriate temporal order (according to the theory of planning by Hayes-Roth & Hayes-Roth, 1979). Moreover, the study investigated how behavior changes during training a0nd if individuals with ID can use technology without an intermediary user.

To determine the feasibility of the training program the following research questions were investigated: (a) Can a tablet-based training program be used without adult supervision for individuals with ID and is there a difference compared to a group with a TD? (b) Is there a difference between a group with ID compared to a group with a TD, on how well they learn the training program and planning tasks? (c) Is there a difference between a group with ID compared to a group with a TD, on how active the participants are in terms of attempts to try to solve planning tasks?

METHODS

Participants

Participants were recruited from schools in southern Sweden. Participation was voluntary. The participants were recruited after the consent of the school's principal. All caregivers signed an informed consent, regarding the confidentiality of data and group-level analysis. All participants gave oral consent at the beginning of the test session. The study follows the Ethical principles for medical research involving human subjects from the WMA Declaration of Helsinki (World Medical Association, 2013). The study was reviewed and approved by the Regional Ethical Review Board in Linköping (2015/119-31).

The participants in the ID group attended upper secondary schools for children with special needs. In Sweden, enrolment criterion for special schools is having a mild to moderate ID diagnosis.[1] The comparison group comprised of children with a TD attending primary schools. The recruitment process resulted in 63 participants ($n_{ID} = 33$, $n_{ID} = 30$).

The participants' MA were calculated based on Raven's colored progressive matrices (RCPM; Raven, 2003). Raw scores were used as suggested by Mervis and Klein-Tasman (2004). A minimum MA of six years was set as an inclusion criterion as it was considered a minimum MA for the participants to be able to plan for themselves. One participant from the ID group was excluded based on this criterion.

Data for one participant had to be excluded due to technical problems with the tablet. As a high percentage of the participants did not train for the instructed 300 minutes. In order to not lose too much data and thereby decrease the reliability of the analysis, cutoff levels for minimum usage time and number of played tasks were formulated. To be included, the participant had to have played at least 10 tasks on each level (see below for details). Visual analysis of usage time revealed that 81% participants trained for at least 180 minutes (12 sessions). Hence, 180 minutes was decided as a cutoff and data from participants playing shorter were excluded. In addition, for the participants to get enough time to meet the criterion of number of played tasks, we stopped analyzing data collected after 200 minutes (rather than 180 minutes). Twelve participants (ID = 11, comparison group = 1) trained for less than 180 minutes and were excluded. Three participants in the ID group did not meet the number of played tasks criterion.

After excluding participants based on the usage trained and tasks played criteria, the groups were matched for MA. Facon et al. (2011) proposed groups be equated on both mean and variance, with an α level of $p > .50$. The comparison group had a higher MA than the ID group, therefore, eight participants from the comparison group with the highest RCPM score were excluded.

After the matching process, the groups did not differ in average performance $t(36) = 0.56$, $p = .581$, nor variance, $F(1, 36) = 0.04$, $p = .839$ on the RCPM. The groups consisted of 38 participants ($ID_n = 17$; 71% girls, $MA_n = 21$; 57% girls). The ID group had a mean chronological age of 17.91 (*SD* = 1.50) years and a mean MA of 8.29 (*SD* = 1.14) years. The comparison group had a mean chronological age of 7.65 (*SD* = 0.74) years and a mean MA of 8.49 (*SD* = 1.01) years. See Figure 1 for a flow chart of the exclusion process.

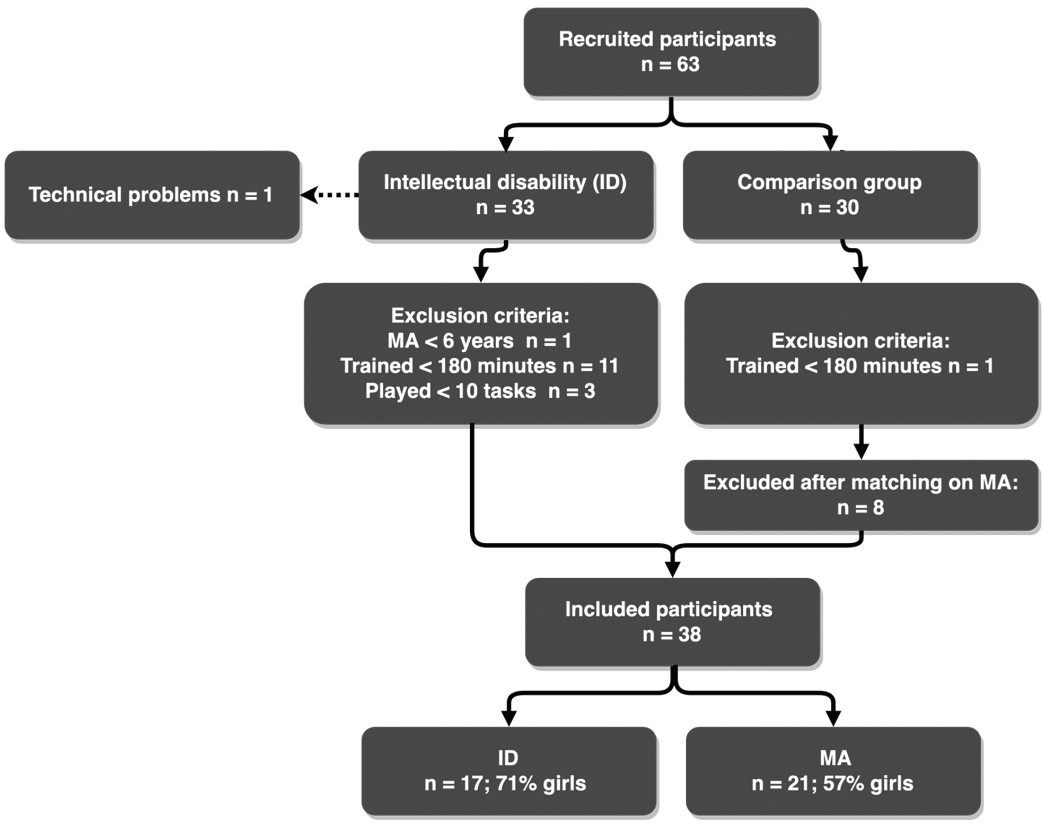

Figure 1. A flow chart of the exclusion process.

Diagnoses

Data on diagnoses were collected using parental surveys. No neurodevelopmental disorders were reported in the comparison group. Data from three participants in the comparison group were missing, but teachers reported that none of the students had special educational needs. No reports on diagnosis were missing in the ID group. The diagnoses in the ID group can be seen in Table 1.

Materials: The Tablet-Based Training Program

A tablet-based training program called *Plan Some More*, was used to train everyday planning. The narrative of the training program was to help an alien named Hensi to create everyday plans. The program was user-driven, meaning the user initiated the actions in the program (e.g., to receive a task, the user clicked on Hensi). The program consisted of a setting with a rocket and a house with four rooms (a bathroom, a bedroom, an entrance, and a kitchen) where everyday tasks were performed. During the training, the user received rewards that could be used to furnish the rocket. The first tasks introduced how to navigate in the program (no planning was required on this level and data from this level was excluded in this study). The planning tasks had three levels of increasing complexity. The more difficult levels were presented when the user had successfully solved six tasks on the easier level. Level 1 required two items ("Help me plan for drinking a glass of water," required items: drinking vessel and water), Level 2 required three items ("Help me plan get dressed for school," required items: underwear, top, and pants/skirt), and Level 3 required four to five items ("Help me plan to make a toast," required items: bread, butter, and a knife for spreading the butter onto the toast) to complete the plan. When the user initiated a task at Level 1–3, the user was first asked to identify the different items needed for the plan (e.g., for the plan "Help me plan to make a toast," the user had to collect a toaster, bread, butter, and a knife for spreading the butter onto the toast). When the user thought s/he got the correct items s/he pressed the play button. If the wrong items were collected or, one or several items were missing, the used was informed of the incorrect answer, without giving specific feedback. When the user had collected the correct items, the user was forwarded to the second part of the task. There, the user was asked to identify the temporal order of the items (e.g., 1. toast, 2. toaster, 3. knife, and 4. butter). Due to the nature of the tasks, several different orders could be correct.

TABLE 1. Diagnoses in the ID Group

Diagnoses	*n*
Mild intellectual disability only	9
Down syndrome	1
William syndrome	1
Mild intellectual disability and attention deficit hyperactivity disorder	2
Mild intellectual disability and language disorder	2
More than one additional diagnosis	2
Total	17

The program was installed on Lenovo TAB 2 A10-30F ZA0C with OS Android 5.1. Data from the participants was logged and included: (a) time spent using the program, (b) number of tasks the user played, (c) whether the participant passed or failed the task, (d) the level of the task, (e) when the user clicked on Hensi (to initiate or repeat the instructions of a task), (f) when the user clicked on a button to check if the answer was correct.

Procedure

The training took place in the participants' school. The participants trained in a group in schools and the teachers were instructed to allow the students to train for 300 minutes (20 sessions for 15 minutes, 5 days a week for 4 weeks). The teachers were asked to let the participants train by themselves and to not assist in solving the tasks for the children. No verbal or written instructions were given to the participants. A research group member attended the first training session to instruct how to operate the tablet and program. All included participants that attended the same class also trained in the same room. However, in some cases only one student in the class participated in the study. Thus, sometimes the participants trained in a group and sometimes the participant sat by themselves, but the participant always trained on their own.

Assessing Feasibility

The training program was considered feasible if the participants used the training program without adult supervision and if the participants improved significantly on the tasks in the training program. The variables *usage time, activity level*, and *improvement rate* were computed from the logged data.

Usage Time. Usage time was extracted from time spent training in the program and was measured in minutes.

Activity Level. The clicks the participants used for initiating a new task and checking if a task was correct was used to measure activity in the program. Activity level was defined as the mean number of clicks per minute and data from the first training session (referred to as the beginning) was compared to the last training session (referred to as the end).

Improvement Rate. To investigate improvement on the planning tasks in the end compared to the beginning, the first and last 25% of the completed tasks were extracted from the logged data.[2] rate. A positive number reflects less errors per task at the end compared to the beginning.

Independent Usage. Independent usage was investigated by studying usage time and improvement rate.

Data Analysis

Assumptions for each analysis were tested. To compare the usage time of the two groups, *t*-tests were used. For group comparisons with equal variance, student's *t*-tests were used, and Welch's *t*-tests were used where the assumptions were violated. To compare the improvement rate and activity level of the groups (ID and MA) mixed-ANOVAs were performed. The dependent variable for the ANOVA investigating improvement was total number of errors made. The within factors were difficulty, with three levels (level 1, level 2, level 3), and time (beginning and end). The between factor was group (ID and MA). The dependent variable for the ANOVA investigating activity was total number of clicks (as defined in activity level). The within factor was time (beginning and end) and the between participant factor was group (ID and MA). The recommended generalized eta squared ($\hat{\eta}_G^2$) was used as an effect size (Bakeman, 2005). Bakeman

(2005) suggested a result of .02 to be considered as small, .13 as medium, and .26 as large. For the within-subject tests, the Greenhouse–Geisser correction was used to correct for violations of sphericity. Post hoc tests were performed using estimated marginal means with a multivariate model and the Tukey's honestly significant difference method was used to correct for multiple comparisons. The α-value was set to .05.

All statistical analyses were performed using R version 3.5.1, in R Studio version 1.1.463 (R Core Team, 2018). The r-packages: dplyr (Wickham et al., 2018), afex (Singmann et al., 2019), car (Fox & Weisberg, 2011), emmeans (Lenth, 2019), and psych (Revelle, 2018) were used. The plots were made in ggplot (Wickham, 2016) and beeswarm (Eklund, 2016). The manuscript was written in R Markdown using papaja (Aust & Barth, 2018) and citr (Aust, 2018) for formatting and references.

RESULTS

The descriptive statistics for all variables can be seen in Table 2.

Independent Usage in the Training Program

The participants were instructed to train for 300 minutes (20 sessions in 15 minutes, 5 days a week for a 4-week period), but only 16% (ID = 8%, MA = 8%) of the participants trained for all 20 sessions. The cumulative distribution of the participant's usage time can be seen in Figure 2. There was a significant group difference on usage time ($t(50.81) = 2.53$, $p = .014$, Cohen's $d = 0.63$. The ID group ($M_{ID} = 219.00$, $SD_{ID} = 76.07$, $range_{ID}$ [68.75 and 327.13]) trained for a shorter time than the MA group ($M_{MA} = 258.90$, $SD_{MA} = 44.89$, $range_{MA}$ [130.56 and 328.76]). There were more participants in the ID group than the MA group that trained for less than the 180 minutes (ID = 11, MA = 1).

TABLE 2. Descriptive Statistics of Included Variables Presented by group.

	Intellectual Disability			Mental Age Matched			
	M	*SD*	*(Range)*	*M*	*SD*	*(Range)*	*p*
Chronological age	17.91	1.501	(16, 21)	7.65	.736	(7, 9)	<.001
Mental age	8.29	1.14	(6, 11)	8.49	1.01	(6, 10)	1.000
Usage time	260	37.1	(191, 307)	253	38.2	(181, 311)	1.000
Activity-level beginning	4.57	1.33	(2, 7)	5.18	1.49	(2, 7)	.970
Activity-level end	7.74	3.97	(2, 18)	5.53	1.86	(3, 10)	.209
Improvement-rate Level 1	1.01	1.424	(−1, 5)	1.59	0.928	(0, 4)	.853
Improvement-rate Level 2	1.44	1.40	(−1, 3)	1.33	1.62	(−2, 4)	1.000
Improvement-rate Level 3	0.788	2.5	(−6, 4)	0.628	1.7	(−4, 3)	1.000

Note. Mental age and chronological age are presented in years. p-values are corrected for multiple comparison. Groups are Compared Using t-tests.

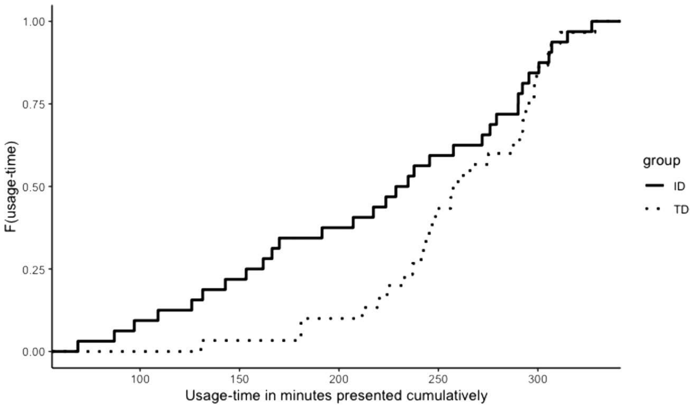

Figure 2. The cumulative distribution of the usage-time. The y-axis equals the proportion of participants and the x-axis the usage-time in minutes. Data is divided into the two groups where the ID group is represented in red and the comparison group in blue.
Note. The results are based on the groups before they were matched on mental age and before the exclusion of the participants that trained less than the usage-time cut-off.

A correlation between the participants' MA and usage time revealed a significant correlation in the comparison group ($r = .404$, $p = .027$), but not in the ID group ($r = .038$, $p = .841$).

Improvement Rate in the Beginning Compared to the End Between the ID and MA Group

The ANOVA on improvement rate for group∗time∗level showed no significant main effects between the groups, ID and MA, ($F[1,36] = 0.02, MSE = 4.25, p = .891, \hat{\eta}^2_G = .000$). The main effect of time was significant ($F[1,36] = 51.19$, $MSE = 1.43$, $p < .001$, $\hat{\eta}^2_G = .131$). Participants made significantly less errors per task at the beginning compared to the end ($\Delta M = 1.13$, 95% CI [0.81, 1.45], $t(36) = 7.08$, $p < .001$). There was also a significant main effect of level ($F[1.33, 47.99] = 56.30$, $MSE = 3.91$, $p < .001$, $\hat{\eta}^2_G = .376$. The participants improved significantly on all three levels (Level 1 = $\Delta M = 1.30$, 95% CI [0.91, 1.69], $t(36) = 6.78$, $p < .001$, Level 2 = $\Delta M = 1.38$, 95% CI [0.88, 1.89], $t(36) = 5.56$, $p < .001$, Level 3 = $\Delta M = 0.71$, 95% CI [0.02, 1.40], $t(36) = 2.08$, $p = .045$). Improvement significantly decreased for the more difficult: levels 1 to 2 ($\Delta M = -1.79$, 95% CI [−2.18, −1.40], $t(36) = -11.21$, $p < .001$), level 1 to 3 ($\Delta M = -2.74$, 95% CI [−3.55, −1.93], $t(36) = -8.25$, $p < .001$), and level 2 to 3 ($\Delta M = -0.95$, 95% CI [−1.61, −0.29], $t(36) = -3.54$, $p = .003$). There were no interaction effects between group∗time ($F[1,36] = 0.10$, $MSE = 1.43$, $p = .756$, $\hat{\eta}^2_G = .000$), group∗level ($F[1.33, 47.99] = 0.05$, $MSE = 3.91$, $p = .893$, $\hat{\eta}^2_G = .000$), time∗level $F[1.82, 65.64] = 2.08$, $MSE = 1.43$, $p = .137$, $\hat{\eta}^2_G = .011$ or group∗time∗level ($F[1.82, 65.64] = 0.61$, $MSE = 1.43$, $p = .531$, $\hat{\eta}^2_G = .003$). The average of errors per task at the beginning compared to end is presented in Figure 3.

Activity Level in the Beginning Compared to the End Between the ID Group and MA Group

The ANOVA on activity level for group∗time showed no significant main effect of group, ($F[1,36] = 1.69$, $MSE = 7.04$, $p = .202$, $\hat{\eta}^2_G = .029$). The main effect of time was significant ($F[1,36] = 12.70$, $MSE = 3.90$, $p = .001$, $\hat{\eta}^2_G = .112$). Multiple comparisons showed a lower activity level in the beginning compared to the end ($\Delta M = -1.76$, 95% CI [−2.69, −0.84],

$t(36) = -3.87$, $p < .001$). Results also showed a significant interaction effect between time and group ($F[1, 36] = 9.57$, $MSE = 3.90$, $p = .004$, $\hat{\eta}_G^2 = .087$). The ID group had a lower activity level in the beginning compared to the end ($\Delta M = -3.17$, 95% CI [−4.55, −1.80], $t(36) = -4.68$, $p < .001$). However, the MA group did not differ over time ($\Delta M = -0.35$, 95% CI [−1.59, 0.88], $t(36) = -0.58$, $p = .565$). No other comparisons were significant (p >.10). Activity level throughout the training can be seen in Figure 4. The interaction effect between groups and activity level can be seen in Figure 5.

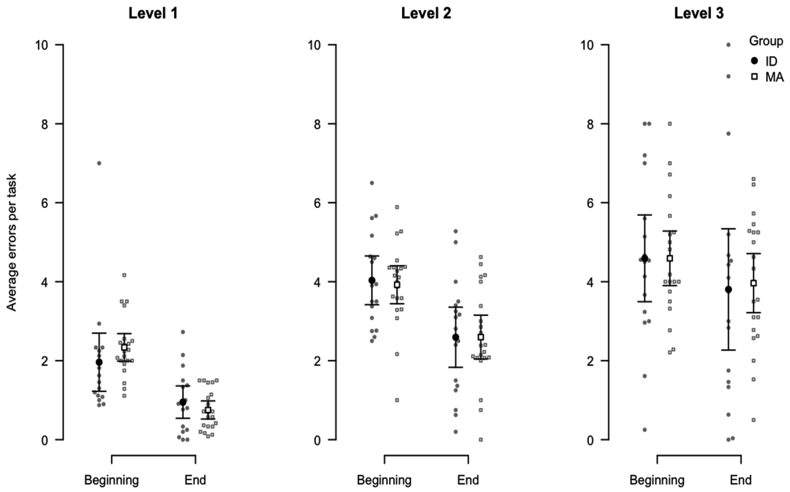

Figure 3. Total number of errors per task separated on group and time for each level. The central tendency measure is represented with means, and error bars represent 95% confidence intervals.
Note. ID = intellectual disability; MA = mental age.

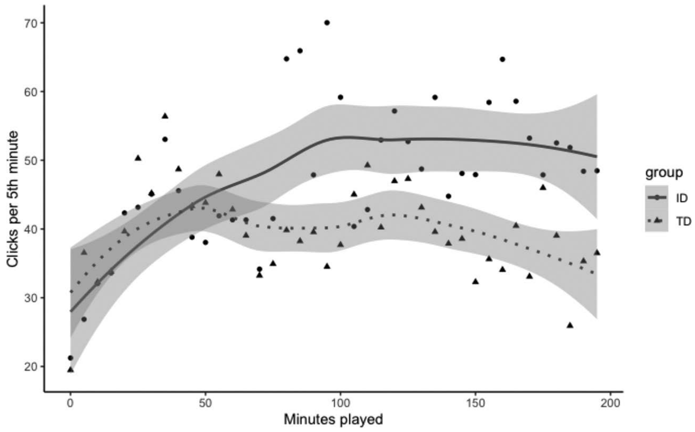

Figure 4. Graph showing clicks per every 5 minutes throughout the training. The number of clicks is presented on the y-axis. Time is presented on the x-axis.

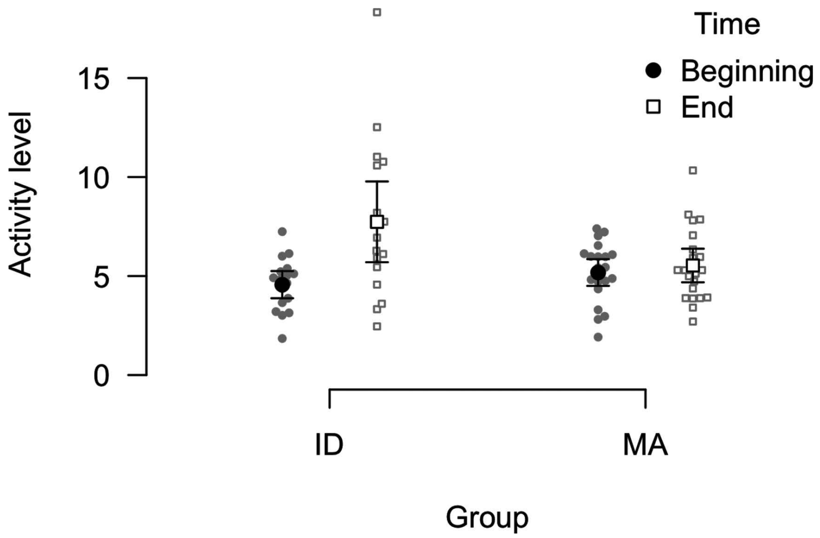

Figure 5. Bee plot of activity level separated by group. The central tendency measure is represented with means. Error bars represent 95% CI.
Note. ID = intellectual disability; MA = mental age.

DISCUSSION

We have presented an everyday planning tablet-based training program and investigated the feasibility of the program for individuals with ID compared to individuals with a TD matched on MA. The analyses revealed several interesting findings. By analyzing data from during the training, we found that the training program was feasible, but only for a subgroup of individuals with ID. Overall, the individuals with ID trained for a shorter time compared to the MA group. The shorter usage time in the ID group was not explained by the participants' MA. Furthermore, the ID group increased their activity in the end compared to the beginning. This change in activity was not found in the MA group. This suggests that the ID group needed a longer time to become familiarized with the training program, but that they caught up during the training. However, the difference in activity level between the groups did not show in improvement rate across levels, where both groups improved their performance equally.

Being Able to Use the Training Program and Compliance

The reason for the why participants with ID trained less than the MA group is not known. Usage time was not correlated with MA in the ID group, indicating that MA cannot account for the difference in usage time in this group. The results imply that the training program for everyday planning is feasible for a subgroup of individuals with ID and that the intervention can be implemented in this population, which is in accordance with the earlier literature on WM training (e.g., Lanfranchi et al., 2017; Söderqvist et al., 2012). However, future research should investigate how to further increase compliance for all individuals with ID throughout the training. Usage time correlated with MA in the comparison group, meaning that participants with a TD and lower MA trained for a shorter period of time. This indicates that the feasibility for individuals with TD and lower MA is lower than for those with higher MA which was not the case for individuals with ID.

Even though the ID group had a higher number of participants not meeting the inclusion cutoff, a majority of the individuals in the ID were able to learn and use the program independently. For those individuals that met the cutoff criteria, there were no group differences between the ID group and the MA group on how much they improved in the program, regardless the level of difficulty of the task. This suggests that individuals with ID were able to learn as much as their MA peers in a program aimed at training everyday planning. Thus, the training program does not appear to require another adult for supervision, which was a proposed reason for the intermediary-usage of ATC (Lisa Palmqvist & Danielsson, 2020). Additionally, as seen in Figure 2, there seem to be a decrease in variability in error rate in the beginning compared to the end for the easiest level, that is, Level 1. This effect is somewhat seen also in Level 2. However, for Level 3, the reduction of variability disappeared. The reason for this lack of reduction in Level 3 seems to be driven by two participants that have increased their error rate in the end, whereas the rest of the participants have a somewhat low score. Thus, we do not think this lack of decrease in variability in the more complex level is a finding true for the group, however, this could be investigated in further studies. The reason for the larger dropout in the ID group on usage time could be due to external factors such as, school absence, sickness, or the teachers forgetting to allow the participants to train every day. These variables were not measured in the study. Thus, the lower feasibility in the ID group might be reduced by more carefully following up on usage time during (and not only after) the training.

The MA group did not show a change in activity during the training, they were using the same number of clicks in the beginning compared to the end of the period. The ID group, however, were increasing their activity and were faster at the end of the training. The increased activity in the ID group cannot explain the higher improvement rate. The improvement rate was calculated by subtracting the number of errors per task at the beginning from the number of errors per task at the end of the training period. That is, the improvement rate does not capture the total clicks in general but the total amount of trials per task. Thus, the improvement rate cannot be improved simply by using more clicks in the training program, but the user must make fewer attempts per task. Rather, the increased activity in the ID group might imply that individuals with ID were using a more careful or perhaps exploratory approach at the beginning of the training. Perhaps, the ID group needed more time to get to know the environment and to feel confident when exploring the program and thus needing a familiarization period. Interestingly, this group difference in behavior was not reflected in a lower learning rate, as both groups improved to an equal extent. The lack of difference implies that the groups did not differ in planning ability, or at least not in their ability to improve in the training program. Instead, the participants might have used different strategies for solving the tasks. As Bray et al. (1997) and Poloczek et al. (2016) have suggested, individuals with ID do use and learn strategies for solving different types of cognitive tasks but use fewer and qualitatively different strategies compared to individuals with TD.

One reason for the difference seen in the group might be due to the difference of Chronological age (CA) in the two groups. The individuals with ID had a higher CA than the comparison groups and thus have lived longer. Research has found that CA contributes to the cognitive ability of individuals with ID which goes beyond their MA. For example, research investigating the effect of CA in individuals with ID found that CA contributed significantly to the receptive language of the participants (Facon & Facon-Bollengier, 1997) and on crystallized intelligence (Facon & Facon-Bollengier, 1999). That is, perhaps the difference seen in the two groups might not only be a result of the ID, but also due to the groups having different CA.

Theoretical Implications of the Difference Between the Groups

The results showed that individuals with ID improved as much as their peers matched on MA, which is in line with the earlier literature stating that individuals with ID perform on par with groups matched on MA on planning tasks (e.g., Danielsson et al., 2010; Numminen et al., 2001; Van der Molen et al., 2007). We could not find that individuals with ID perform at lower levels than their mentally age-matched peers, which Danielsson et al. (2012) found in their study.

This study investigated the activity level during the training, and therefore, were able to compare if the groups differed in strategy use when learning the program. It was found that the ID group needed a familiarization period before they were as active as the participants in the MA group. We, therefore, hypothesize that individuals with ID are using different strategies compared to the MA group when solving the tasks in the beginning, but that they develop their strategies throughout the training. This behavior was unique to the ID group and could not be observed in the MA group. The captured the difference in familiarization between the groups can be explained by the groups demonstrating both qualitative and quantitative differences in strategy use.

This way of analyzing intervention data can provide new ways of testing cognitive theories of ID. The most common models of ID are the difference model and the developmental delay model of ID (Bennett-Gates & Zigler, 1998). The difference model of ID states that individuals with ID have specific deficits in cognitive functioning and atypical cognitive development. This model is contrasted by the developmental delay model which states that individuals with ID follow the same pattern of development as individuals with a TD, but progress at a slower rate (Bennett-Gates & Zigler, 1998). The results from our study, suggest that even though the groups were matched on MA, individuals with ID differ qualitatively from individuals with a TD, a result in line with the difference model of ID (Bennett-Gates & Zigler, 1998).

CONCLUSIONS

A tablet-based program offers a potentially feasible intervention for teaching everyday planning to adolescents with ID, but usage time should be monitored during the training. The outcomes of this study suggest that a tablet-based training program can be beneficial for adolescents with ID and the intervention has the potential to be implemented as part of a daily program of instruction within a school setting. Furthermore, the study found that individuals with ID needed more time to get used to the program but were still able to learn as much as their MA peers. This shows that it is important to consider the length of time when assessing digital support for this group. Finally, the difference in behavior in combination with a similar learning outcome provides evidence in favor of the difference model of ID when describing tablet-based planning training.

FUTURE CONSIDERATIONS

Even though many participants did not train as much as intended, both groups were able to display learning in the task and both groups were able to independently navigate in the program without the help of another adult or teacher. This result is promising with regards to using tablet-based training programs for interventions for individuals with ID, but also highlights the importance of monitoring that the training is carried out.

This study did not test the possible effect to untrained tasks nor assessed possible maintenance effects. Thus, the next step is to investigate the potential transfer effect to untrained tasks and to assess the individuals' proficiency in everyday planning, to increase their independence and reduce the role of intermediary users. Further, future studies should investigate if the training effects are maintained over time.

The results emphasize the importance of bearing in mind the familiarization period when assessing and evaluating the efficacy of a cognitive support and intervention programs, such that an ATC or intervention is not discarded before the individual has had enough time to get used it.

NOTES

1. In Sweden, the diagnosis Intellectual Disability is made after a thorough assessment by a licensed psychologist according to criteria from the DSM-5 (American Psychiatric Association, 2013).
2. The choice to use percent of completed tasks rather than using the first and last sessions was to ensure that the same number of tasks were performed in the beginning and end.

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