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The relationship between prospective memory, working memory and self-rated memory performance in individuals with intellectual disability

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In the present study, prospective memory, working memory and self-rated memory performance were assessed in five individuals with intellectual disability and 10 individuals without intellectual disability. Prospective memory was taxed by means of a video-based procedure and a more naturalistic task, working memory was taxed by means of digit and picture span tasks, and a questionnaire was used to measure self-rated prospective and retrospective memory. The spread of performance was wide on prospective memory and working memory tasks, foremost for individuals with intellectual disability. Self-rated memory did not differ between the two groups, although there were large differences in memory performance on the other memory tasks. The results are interpreted in terms of how limitations in working memory contribute to prospective memory failures among individuals with intellectual disability. To remember 'when to' perform a prospective memory task seems to be more difficult to master than remembering 'what to do' for individuals with intellectual disability.

Keywords: prospective memory; working memory; intellectual disability

What do you think about someone who never keeps an appointment? What if your plans always came to nothing? Prospective memory refers to the ability to remember to perform intended actions in the future (for example, to turn off the stove when the eggs are boiled or to celebrate an anniversary). Prospective memory is a fundamental aspect of cognitive functioning that exerts an influence on the individual's control over future events. The ability to remember to act on an intention in the future has far reaching consequences for practical, academic as well as social skills. Thus, prospective memory function can even motivate if an individual is considered to be reliable (see, for example Ellis and McGann 2003). Since prospective memory function relies on integration of task performance with time perception (i.e. understanding that time is passing) prospective memory may be both a prerequisite for and a consequence of adaptive behaviour. Prospective memory represents a unique cognitive ability (Salthouse, Berish, and Siedlecki 2004), that depends on an interplay between the individual's cognitive abilities (cf. Smith 2003), motivation (see, for example Patton

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and Meit 1993), support and the situation requiring a prospective memory. Adaptive behaviour is used in definitions of: (a) intellectual disability (American Association on Mental Retardation 2002); and of (b) intelligence (Sternberg and Salter 1982). Prospective memory can be interpreted as an aspect of adaptive behaviour that influence practical and academic skills in situations associated with a time delay, and social skills (to attend appointments or to perform tasks as promised, for example).

In this study we will focus on a group of individuals with intellectual disability. Numerous everyday life observations reveal that prospective memory failures are prevalent among individuals with intellectual disability and thus impose limitations in everyday functioning. Cognitive components and processes that would contribute to a weak prospective memory performance among individuals with intellectual disability are for example; limitations and extensive variation in working memory capacity (see, for example Henry 2001; Numminen, Service, and Ruoppila 2002) and difficulties in shifting between different tasks (see, for example Dulaney and Ellis 1997) or strategies (see, for example Bray, Fletcher, and Turner 1997). Prospective memory has previously been studied in special populations (e.g. normal aging, traumatic brain injuries); however, not in individuals with intellectual disability. Investigations of prospective memory and how it relates to other memory systems in individuals with an intellectual disability may afford theoretical support and/or new ideas for interventions (i.e. memory aids or memory training) to improve prospective memory function. Adequate prospective memory function in part prepares the ground for independence in everyday life, by low demand for reminders, or allowing the individual to keep up a social life of his/her own, for example.

Failure in prospective memory can result from different aspects of the prospective memory situation such as retrieval of 'what to do,' or recognition of 'when to do.' Prospective memory function demands perception of time and often benefits from strategic behaviour that tax working memory capacity (cf. Smith 2003). Working memory is a memory system that is responsible for temporary storage and processing of information over a short time (typically 5–15 seconds). Previous research has demonstrated that working memory is restricted among individuals with an intellectual disability (cf. Henry 2001). Strategy competence refers to abilities such as drawing upon strategies and using them in a way adequate to the requirements of the situation (Bray et al. 1997), and is essential especially in prospective memory situations that impose high demands on working memory (Walker and Ellis 2003).

The time delay that precedes the performance of the prospective memory task imposes a demand on long-term memory function (i.e. storage and retrieval of intentions from a permanent memory). Prospective memory is, thus, a composite function that relies on adequate integration of information from long term memory and working memory functions. Weaknesses in long-term and working memory functions can furthermore result in unawareness of prospective memory failures such as forgetting to buy something (see, for example Wilkins and Baddeley 1978). Thus, contributing to discrepancies between more objective measures and self-rated memory function (see, for example Perfect and Stollery 1993). Self-rated memory is an aspect of meta-memory that is related to cognitive development and intelligence (Borkowski 1996), thus predicted to be limited especially among individuals with intellectual disability. In sum, prospective memory performance is partially shaped by: (a) an intricate interplay between working memory capacity and related cognitive functions, such as long-term memory; (b) by experience, strategies and contextual support; and (c) specifically by the individual's self-rated memory.

The purpose of this study is to examine and compare the relationship between prospective memory, working memory, and self-rated memory performance (cf. Marsh et al. 2002) in individuals with and without intellectual disability. In this study, we will examine five adult individuals with mild to moderate intellectual disability (American Psychiatric Association 2000). A 'minimal' level of time perception, to relate to time in relation to everyday life situations and to use of some form of time-aid, formed the inclusion criteria.

Method

Participants

The present study was a group study with data from five individuals with intellectual disability who worked at day activity centres. Three women and two men with mild to moderate intellectual disability participated (chronological age: M = 27.5, SD = 5.97). A common practice among individuals with mild to moderate intellectual disability in Sweden is to, during the weekdays, alternate between going to work, going to school, and to 'practicing at home.' This is an activity where the individual practices how to run life at home (e.g. doing laundry or cleaning). Adult individuals with intellectual disability were selected based on their current use of time aids or because staff expected that the person could benefit from using such devices. All participants had a spoken language (with signs as a complement for person 1) and reported that they occasionally watched films on TV. Three participants could read simple texts (persons 1, 2 and 5), two of the participants mentioned impaired hearing (persons 1 and 2) and four participants regularly went to school (persons 2, 3, 4 and 5). Comprehension of abstract notions such as 'hour' or 'minute' was limited (persons 1, 2, 3 and 4). An ordinary watch was however used by some individuals (person 1, 2 and 5), and all participants reported that they were familiar with the clock face (i.e. person 3 could identify the 'coffee-break clock face'). All participants were able to talk about future and past events. Ten individuals without intellectual disability (nine female and one male), all students in behavioural science, matched on age (M = 27.3, SD = 5.0) also took part in this study as controls. They were recruited from an introductory course in psychology.

Individual descriptions

Person 1 was, at the time of the study, 22-years-old and was moving from her parent's home to an apartment of her own. She had a hearing impairment and often sent printed messages on her cell phone to communicate with friends outside work. Person 1 used basic counting skills in the work situation. She was very attentive to other individuals' needs.

Person 2 was 26-years-old. She could read, but used pictures as a complement, for example in 'The 15 min watch' (Granlund et al. 1995). This watch is a special digital device that tells time using time-coded graphic cards. When a card is inserted into the watch, lights indicate how many 15 minute segments remain until the event is about to take place. Person 2 chose which card to use during the day herself, and at work she used a schedule based on pictures. She made plans such as lunch appointments with her boyfriend.

Person 3 was 34-years-old, lived on his own and went to work by bus. When he had important appointments someone would phone and remind him. He practiced to understand difficult words and to read at school, and he found pictures useful. At home, person 3 used a '15-min watch' with three different time-coded graphic cards that he received help to change. Person 3 knew when his favourite programs were broadcast but he did not always know the day of the week.

Person 4 was 26-years-old and he lived with his parents. At school, he practiced reading, which he found very difficult. He said that he liked digits, but not pictures. Person 4 was not certain of the day of the week, but he knew that he went to school every Wednesday and that Swedish films often were broadcast on Mondays. He had a calendar (in his bag) but he did not seem able to keep track of when different events were actually to take place.

Person 5 was 36-years-old and lived in her own apartment. She used an ordinary watch and clock as well as a '15-min watch' with mainly written messages on the time-cards some of which were colour coded to indicate what day they were to be used. Person 5 was aware of her disability and used a plan for the week in combination with an ordinary calendar and the 15 minute watch as a reminder so that she could keep her appointments. She could read and write short messages and learned English at school.

Tasks and materials

Short delay prospective memory

The short delay prospective memory task (range: 0–24) was based on the Laurel and Hardy film 'Flying Deuces' (70 minutes), and inspired by the Prospective Remembering Video Procedure that was suggested by Titov and Knight (2001). The film 'Bogus Bandits' was used for test runs. The expressive body language of Laurel and Hardy made the spectator's verbal understanding less influential. The video-based task was chosen since it can be adapted to the everyday life situation of the individual. In Titov and Knight's (2001) study, participants received tasks to solve when watching video segments made when moving through shopping areas. Degree of familiarity with the shopping area where the film had been recorded was found to influence prospective memory performance. In this study, the choice of video-material was altered because familiarity with shopping and shopping areas was known to vary among the participants.

The number of tasks to complete in connection with prospective cues was two per film-section. Four prospective cues (distinct events in the film) were formed for each of the following categories: vehicles, animals, spouts of liquid, romantic events, music, or actions performed by the characters in the film. The purpose was to check whether or not the performance of the individual was drastically influenced by special interest in certain categories of prospective cues (mean correct prospective memory performance for each category ranged from 3.6 to 3.9 for individuals without intellectual disability and from 0.2 to 1.2 for individuals with intellectual disability). Gestures were used as tasks to perform in order to reduce the impact of word mobilisation skill on short delay prospective memory performance. The gestures that were used as tasks to perform in association with prospective cues were: to pretend to turn a steering-wheel, to pretend to pet an animal, to point and make the experimenter notice something that happened suddenly, to touch one's shoulder, to pretend to turn up the volume, and to turn one's head. Each task was used twice in connection with a prospective cue that was related to the task and twice in connection with a prospective cue with no obvious relation to the task (i.e. to pretend to turn a steering-wheel when a car was shown in the film or to pretend to turn a steering-wheel when you see a camel). Twenty-four cues were divided among 12 sections varying in length between 2 and 8 minutes. If a participant forgot to perform a task in connection with a prospective cue (within 30 seconds from its first appearance), the researcher stopped the tape and provided extra cues until the correct behaviour was reached. Extra cues were: 'you should turn something,' 'you should do something with your hand,' 'you should show something,' 'you should touch something,' 'you should imitate something,' or 'you should make a movement.' All extra cues could occur four times and were balanced between prospective memory situations that varied in relation to the prospective memory cue (i.e. 'you should show something' is more useful as an extra cue for the task 'to point' to than for the task 'to pretend to turn a steering wheel' that would get more support from an extra cue such as 'you should turn something').

Recognition task

The recognition task (range: 0–12) was based on 12 orally presented true or false statements (six each) about the actions that had been performed previously during the short delay prospective memory task. The participant answered 'yes' or 'no' to the question if the action had been presented previously. If they asked about the meaning of a statement, the action was performed. This task was thought to some extent to reflect the retrospective component of prospective memory.

Long delay prospective memory

The long delay prospective memory task (range: 0–5) was to fill in and to return a form by post on the following day (an envelope with an address was handed out). The form was based on three rows of symbols: a happy, a neutral and a sad smiley; squares filled with the colours representing the days of the week; and five different weather symbols. Instructions were written above each row of symbols and the name of the corresponding day was written below each coloured square. Scoring was made with respect to: (a) if the letter was returned (1 point); (b) if it was returned approximately at the correct day (1 point); and (c) degree of completion of the form (0–3 point).

Working memory tasks

Two visually presented tasks: (a) picture position span (range: 0–60); and (b) digit span (range: 0–240), were used to study working memory. These span procedures were predicted to tax somewhat different cognitive abilities. The objective of using a digit span task was: (a) to relate the picture position span to an established task (see, for example Cornoldi and Guglielmo 2001); and (b) to explore if digit span performance was related to prospective memory performance, especially for individuals with intellectual disability. The picture position span task was based on four different categories of pictorial material (i.e. photos and drawings of non-living objects or individuals, in case this affected working memory performance) that was presented in a traditional span procedure. The picture position span task included two versions (based on similar but not identical pictures) that varied in demands for concurrent mental processing (henceforth denoted hard and easy). The hard version required the participant to make a decision for each presented picture, resembling a reading span test paradigm (Daneman and Carpenter 1980). For a picture of a face, the decision was if it was a 'he' or a 'she.' For pictures of objects, the decision was if the object is soft or hard. The picture position span included three within-participants variables: hard or easy (differing in the need for concurrent processing); photos or drawings; and non-living objects or faces of persons. The repeated measures variables were orthogonally balanced.

Pictures were presented one at a time for 1 second (inter-stimuli interval 0.075 second) at their position in a span. When the last picture had faded, all the pictures in the current span were presented in the upper half of the screen. The task was to recall the order in which the pictures initially were shown. At the bottom of the page there were empty spaces where one position, initially the first one, was brighter than the rest. The participant chose which picture to place at the bright square, either with a mouse-click on the picture or by indicating to an assistant who handled the computer which picture to choose. Then the bright square moved to the next position until the end of the span was reached. Three trials of each list length were used and span length (i.e. the number of pictures), was increased one picture if the participant successfully recalled at least one of three lists. This procedure continued until failure or the maximum length of six pictures was reached. Four tasks based on the pictures were delivered consecutively and followed the same basic procedure. In this study, the order of the tasks was fixed as follows: photos of non-living objects, photos of individuals, drawn pictures of objects, drawn pictures of people.

Scoring on the picture position span task was made with respect to the number of pictures recalled in the correct position. This scoring procedure was employed as it correlates significantly with number of pictures recalled in a correct serial order (r_s $(120) = 0.97$, $p < .001$), number of correct recalled spans (r_s $(120) = 0.99$, $p < 001$), and the span size (r_s $(120) = 0.95$, $p < .05$, where two out of three spans recalled with .5 credits added for any extra span).

Digits were presented in random order with SuperLab Pro, Version 2.0, one digit every 2 seconds. Span size was increased by one digit for every second span that was presented until none of the two spans of a certain length was recalled correctly. Performance on the digit span task was operationalised as the total number of digits recalled in correct serial order.

Self-rated memory

Raw scores were converted to T scores (range: 5–74). The prospective and retrospective memory questionnaire, PRMQ (Crawford et al. 2003), has been used for self-rating of prospective and retrospective memory in everyday life in a general adult population. Situations in everyday life that involve a long-term or short-term delay and that depend on the use of external cues or of internal cues are included (e.g. 'How often do you decide to do something in a few minutes' time and then forget to do it?,' which is prospective, short term and self-cued). The participants rate how often they think they forget in a similar situation. A Swedish translation of the prospective and retrospective memory questionnaire (Crawford et al. 2003) was used for self-rating of memory in the current study.

Procedure

Participants had previously been informed that the focus of the study was time and use of time-aids. The individual's consent to participate in the study was confirmed. For each task, participants were informed about the procedure that was to follow by verbal instructions and by test runs (except for the long delay prospective memory task) to make the task situation more familiar. In order to establish better comprehension, the experimenter performed an initial task and there were opportunities to pose questions. Test runs continued until the participant's performance indicated understanding and no further questions remained. The experimenter was present during all tasks.

In connection with the short delay prospective memory task, the participant was informed of the basic plot of the film used in the actual study and asked if they had seen the film before. On the two occasions when written messages appeared in the film, these messages were translated into Swedish. Since not all of the participants were able to read subtitles, major events in the film were explained by the experimenter. It was ensured that any additional information did not occur at the same time as cues appearing in the film. Short delay prospective memory tasks were orally delivered, two at a time, in the same order as the prospective cues occurred in the film. If a response to a short delay prospective memory cue was not delivered within 30 seconds of its first appearance; a supportive extra cue was delivered. After this task had been completed, a recognition task of the actions that had been performed was verbally conducted. At the end of the session, a letter to fill in and mail the following day was distributed.

The picture position span task procedure (performed at a later occasion) was initiated with a test run of four spans demonstrating the procedure and introducing pictures similar to the stimuli material used in the following tasks. The picture position span task with low demands on concurrent processing preceded the test run that prepared participants for the picture position span task with high demands on concurrent processing. The digit span task was then presented on the same computer and answers were delivered orally by the participant.

The PRMQ questionnaire was delivered on a third occasion. Less-skilled readers received help reading the questions and the alternative responses were repeated for each question. Distribution of the PRMQ to individuals with intellectual disability resembled a structured interview. Examples from their own life were provided (if needed) in order to establish better understanding of the content of a question or response alternative.

Observations

Participants' experience with the video-based material

The individuals without intellectual disability had usually not seen the particular film with Laurel and Hardy used in this study, but they were familiar with the characters. The individuals with intellectual disability enjoyed the movie and seemed highly motivated to perform well. Person 4 was acquainted with the film 'Flying Deuces.'

Laurel and Hardy seemed to be annoying to person 1 who seemed to predict what would happen when they did stupid things, to the others it was amusing. Persons 2, 3, 4 and 5 said that they enjoyed the film and laughed from time to time.

Behaviour on the prospective memory tasks

For the individuals without intellectual disability, the situation was interpreted as a memory test and when they focused on the task they performed well. Performance indicated that the task was easy for individuals without intellectual disability, but obstacles such as getting too involved in the film, almost falling asleep, or thinking about other things were mentioned. Mistakes made by individuals without intellectual disability often involved a mix-up of who was supposed to be the agent (Laurel or Hardy) or other detailed judgements that persons with intellectual disability did not mention. Among individuals without intellectual disability, involuntary transfer was merely a tendency. For example, their hands moved but before performing any gesture they remembered that the task was to move their head. Individuals without intellectual disability identified patterns among tasks and cues they tended to notice cues that recurred in the same section that made the short delay prospective memory task easier. A common behaviour was to repeat the cue and task verbally as they were delivered (person 2, 4, 5 and some individuals without intellectual disability) or to repeat the gestures (tasks; person 2, 3, 4 and 5). Person 5 said that 'jag måste göra så' (I have to do that) referring to repeating the tasks. Person 2 asked in what order the cues would occur. The section where the task was the same for both cues was identified as being easy (person 4). During the delay, cues and tasks could be rehearsed verbally (person 2, 3 and 5) or gestures could be carried out (person 3 and 5). Person 3 and 5 expressed that the task got easier after some training.

Involuntary transfer of cues or tasks between different sections, or both in combination occurred (person 3, 4 and 5). After a while, person 3 seemed to prefer some tasks as answers when receiving a cue or just performed vague hand-movements. When asked about the nature of the cue, the answer was usually 'det var innan' (it was before), which was true, but not the correct answer. Person 3 said that he had not thought that he would manage to see the whole film. Person 4 performed better on cues that were present for a longer time. The importance of a connection between cue and task was indicated by the mistakes made when a person chose the wrong cue or task or invented their own items. An aeroplane was identified as a cue when the correct cue was white doves (both can fly, have wings, etc.). The cue music made the person guess that the task was turning up the volume, and when the cue was Oliver waving with his tie person 4 was certain that the task was pretending to put on a tie (a task that never was used but occurred in the film). Person 3 guessed that pretending to hug someone was the task associated with the cue kissing. Comical and distinct events in the film often involved water, which may have influenced person 4 to decide that Laurel falling into the water was a cue. The cue was incorrect but resembled cues that were used.

The long delay prospective memory, to fill in and return a form by mail, made person 5 talk about different occasions when she would have an opportunity to post the letter. For example, she could mail it when she went to school. She also seemed to make a 'mental note' as she stated that she had two things to do in the evening, her homework and filling out the form.

Results

The results will be presented in the following order: Short delay prospective memory task performance, performance on the recognition task (d' and beta), performance on the long delay prospective memory task, the picture position span task, the digit span task and PRMQ scores. An alpha level of .05 was adopted for all statistical tests unless otherwise reported. Equal variance was assumed for group-comparisons unless significant result on Levene's test for equality.

Prospective memory performance

Short delay prospective memory performance was measured as the number of correct tasks performed in connection with the correct prospective memory cue. In total (see Table 1), control participants performed much better than the intellectual disability participants ($t(13) = 9.78$). Extra cues, to varying degrees, improved recall of the content on the short delay prospective memory tasks (on a group level performance went from 95% to 97% for controls compared to from 22% to 52% for individuals with intellectual disability). The ceiling effects for the controls inhibited their support from cues of course, but on the other hand participants with intellectual disability were clearly supported by extra cues.

Prospective memory recognition after the prospective memory task

Control participants recognised most of the tasks that had been performed in association with the short delay prospective memory task (11.2 out of 12). In contrast, individuals with intellectual disability (except person 5) had difficulties in distinguishing between performed prospective memory tasks and new tasks (lures).

Long delay prospective memory

Control participants returned only 20% of the letters in the long delay prospective memory task whereas intellectual disability participants all returned a letter, however a letter was not distributed to person 1, and person 3 did not fill in the form.

In sum, the performance level on the short delay prospective memory task, among people with intellectual disability ranged from 0 to 50% compared to almost perfect recall performance by the control participants. Performance on the prospective memory recognition task for individuals with intellectual disability ranged from chance levels to equal performance levels with individuals without intellectual disability. The differences between performance on the short delay prospective memory task and recognition task may be an indication that short delay prospective memory depends on other skills than simply retrospective memory of task content. Prospective memory performance of individuals with intellectual disability can in part be attributed to failures in retrospective memory and to limitations in working memory capacity that influence many other cognitive processes of importance for prospective memory (e.g. the use of strategies).

Table 1. Prospective memory and working memory performance for individuals with or without intellectual disability.

Test	Individuals With Intellectual Disability									Individuals Without Intellectual Disability				
	Person 1	Person 2	Person 3	Person 4	Person 5	M (SD)	Min	Max	n	M (SD)	Min	Max	n	t
Prospective memory	0	5	0	8	13	5.2 (5.54)	0	13	5	22.70 (1.34)	20	24	10	6.962[a]*
Prospective memory With cue	4	9	7	11	5	7.2 (2.86)	4	11	5	0.70 (1.06)	0	3	10	3.653[a]*
Prospective memory lapses	2	2	15	3	2	4.8 (5.72)	2	15	5	0	0	0	10	1.877[a]*
Recognition	–[b]	–[b]	6	7	10	7.67 (2.08)	7	10	3	11.2 (.63)	10	12	10	2.90 [a]
d’	–[b]	–[b]	−2.24	−3.73	.10	−1.96 (1.93)	−3.73	.10	3	.59 (.94)	−1.98	1.26	10	3.262*
criterion	–[b]	–[b]	−1.53	.39	−.36	−.50 (.97)	−1.53	.39	3	.15 (.41)	−.07	1.26	10	1.781
Long delay prospective memory	–[b]	5	1	5	5	4 (2)	1	5	4	3.20 (2.15)	0	5	10	.640
Picture span	142	45	70	83	98	87.60 (36.10)	45	152	5	415.60 (42.21)	344	462	10	14.813*
Less complex picture span	87	20	44	46	55	50.40 (24.21)	20	87	5	211.10 (18.02)	177	233	10	14.57*
More complex picture span	55	25	26	37	43	37.20 (12.50)	25	55	5	204.50 (26.52)	153	232	10	16.59[a]*
Photos	82	22	28	41	70	48.60 (26.28)	22	82	5	204.00 (24.67)	161	231	10	11.27*
Drawings	60	23	42	42	28	39.0 (14.46)	23	60	5	211.60 (18.71)	182	234	10	17.99*
Objects	83	18	39	64	62	53.200 (25.11)	18	83	5	212.30 (21.37)	163.0	236.0	10	12.86*
Individuals/faces	59	27	31	19	36	34.40 (15.09)	19	59	5	203.30 (24.52)	154.0	232.0	10	13.98*
Digit span	12	9	4	8	22	11.00 (6.78)	4	22	5	52.7 (8.84)	40	74	10	9.211*
Self-rating of prospective memory	52	48	–[c]	–[c]	44	48.00 (4.00)	44	52	3	50.89 (7.69)	40	66	9	.610
Self-rating of retrospective memory	55	41	–[c]	–[c]	47	47.70 (7.02)	41	55	3	48.33 (17.09)	5	63	9	.95

Notes: [a]Equal variance not assumed (significant result on Levene’s test for equality in variance).
[b]Task not distributed.
[c]Unable to perform task.
*$p < .05$

Working memory performance

Working memory capacity was estimated by performance on visually presented digit spans and picture position spans. The results for the picture position span was analysed by means of an ANOVA in a mixed factorial design. Only effects related to the manipulation check (easy/hard) and participant constellation are presented. The ANOVA revealed the following pattern: First, a main effect of participant constellation emerged ($F\ (1,\ 13) = 516$, $p < .05$, $MSE = 204$). Second, the easy version (i.e. without concurrent metal processing) was significantly easier than the hard version ($F\ (1, 13) = 5.32$, $p < .05$, $MSE = 30.7$). There was also a tendency for an interaction ($F\ (1, 13) = 4.03$, $p = .10$, $MSE = 30.8$), which indicated that participants with intellectual disability in particular had problems with drawings compared to photos. For the digit span task, performance differed significantly between the groups such that individuals with intellectual disability performed at a significantly lower level compared to individuals without intellectual disability ($t(13) = 9.21$, $p < .001$).

Taken together, the analysis for the picture position span revealed that participants with intellectual disability performed less well than the controls, especially where the stimuli material was constituted by drawings. In this study, performance on spans based on pictures of faces was good for individuals without intellectual disability, although several of the participants orally reported that they found the task more difficult than pictures of objects. Individuals with intellectual disability were often unable to perform the additional task that was used in the picture position span that posed high demands on concurrent processing. The correlation between the picture position span and the digit span performance was non-significant for both groups.

At an individual level, person 1 deviated from the obtained empirical pattern (see Table 1) such that performance on the picture position span task was very high and there was not a corresponding level of performance on the digit span task. For the other individuals there was less difference in performance on the two working memory tasks.

There may be a qualitative difference in what digit span and picture position span tasks reflect for individuals with intellectual disability and individuals without intellectual disability, considering that the two groups performed close to the two extremes. Working memory performance was at occasions close to zero, regardless of how responses were delivered, for several individuals with intellectual disability. Overt processing of the presented material, that seemed to be a necessity for individuals with intellectual disability, interfered with the additional task used in the high demand working memory task. Individuals with intellectual disability overtly named digits during the digit span task, which individuals without intellectual disability occasionally did at the beginning, although they stopped when they heard their own voice. A possible explanation is that they had enough working memory capacity to consider different strategies.

Self-rated prospective and retrospective memory

There were no significant differences in self-rated prospective memory and retrospective memory based on the PRMQ (Crawford et al. 2003) between individuals without intellectual disability and individuals with intellectual disability (see Table 1 for details). Neither group rated their prospective memory to be significantly different from their retrospective memory; these scoring results are similar to those reported by Crawford et al. (2003).

Self-report questionnaires often include questions that are problematic for individuals with intellectual disability (e.g. concepts). In the present study, individuals with intellectual disability had difficulties imagining a situation where they did not use the strategy they were used to using. For example, person 5 described how she wrote down messages. Persons 1, 2 and 5 could answer the questions after discussing the meaning of the statement and when examples from everyday life were provided. Persons 3 and 4 could not answer the PRMQ due to a lack of conceptual knowledge of the meaning of the response alternatives.

Prospective memory, working memory and self-rated memory

Performance on the short delay prospective memory task was neither significantly correlated with PRMQ score nor with picture or digit span performance for individuals with or without intellectual disability.

Individual by individual analysis

Performance on the tasks used in this study revealed individual differences in memory that were more prominent among individuals with intellectual disability than among individuals without intellectual disability. For example, neither person 1 nor person 3 performed any correct responses on the short delay prospective memory task without help from extra cues, but they differed both in working memory performance and skills needed to complete the self-rating questionnaire. Support from extra cues improved prospective memory performance for all individuals with intellectual disability and for some for individuals without intellectual disability. Individuals without intellectual disability made few mistakes and needed few extra cues on the short delay prospective memory task. There was no significant difference in the need for extra cues between different categories of prospective memory tasks (i.e. mean correct prospective memory performance for each category ranged from 3.6 to 3.9 for individuals without intellectual disability and from 0.2 to 1.2 for individuals with intellectual disability).

Instead of performing the short delay prospective memory task, person 1 often retold what had happened in the film when the film was stopped and she received extra cues. Her picture position span performance at occasions was near the performance level of individuals without intellectual disability, but her digit span performance was similar to the mean performance among individuals with intellectual disability in the present study. Short delay prospective memory performance of person 2 improved with extra cues and her performance on the recognition task and the picture position span task was close to chance level. Person 3 never performed a prospective task until the film was stopped. On the recognition task that required discrimination between prospective memory tasks (gestures) that either had or had not been performed previously in the study, person 3 gave the answer 'ja' (yes) to all statements. Acquiescence sometimes occurs, for example in interviews, with individuals with intellectual disability (Finlay and Lyons 2002), but it has been argued that event memory is less susceptible to this problem (Beail 2002). Digit span performance for person 3 was limited but performance on the picture position span task was more similar to the group mean for individuals with intellectual disability. Person 4 performed fairly well on the short delay prospective memory task but not on the recognition task or digit span. Span length seemed to improve on the picture position span. Person 5 was quite skilled on the short delay prospective memory task, especially on the recognition task, and also performed fairly well on the picture position span and digit span task.

In sum, performances indicated that prospective memory, recognition, and working memory are more limited among individuals with intellectual disability than among individuals without intellectual disability. This pattern may to some extent explain similarities self-rated memory functioning between the groups, if intentions that never are performed are not noticed. Limitations in working memory are expected to influence, for example, processing that support encoding of intentions and capacity for noticing the prospective memory cues while performing the ongoing activity.

Discussion

The objective of this study was to investigate prospective memory and how it relates to working memory and self-rated memory in individuals with and without intellectual disability. As expected, the results revealed differences between the two groups and more pronounced individual differences were displayed in the intellectual disability-group. The short delay prospective memory, recognition, picture and digit span tasks were all difficult for individuals with intellectual disability. Their performance ranged from chance level to 50% of the performance of individuals without intellectual disability. Self-rated memory, in contrast, did not differ between the groups. This discrepancy may be an indication of a limitation in meta-memory skills among individuals with intellectual disability.

Performance on the short delay prospective memory task improved with extra cues, especially for individuals with intellectual disability for whom omissions of prospective memory tasks without cues were common (cf. Einstein and McDaniel 1990). Short delay prospective memory is a composite cognitive task that includes a number of cognitive operations, such as encoding, storage and retrieval of a prospective memory task and the ability to shift between tasks once the appropriate prospective memory cue is noticed. Characteristics of the prospective memory situation e.g. cue frequency (see, for example Ellis, Kvavilashvili, and Milne 1999); cue characteristics, the ongoing activity, the participant, etc. (see, for example Brandimonte and Passolunghi 1994), may influence prospective memory performance.

In this study, three explanations for the outcomes will be discussed. Limitations in: (a) retrospective memory capacity; (b) attentional resources; or (c) working memory capacity. The discussion of quantitative results will be substantiated by observations from the study setting.

Encoding of the retrospective aspects of prospective memory, that is 'what to do,' in connection with specific prospective memory targets, that is 'when to do,' depends on mental processing, e.g. strategies. Mental processing in turn is likely to tax working memory resources. What were likely overestimations of self-rated memory for individuals with intellectual disability suggests that what the individual thought or remembered to have performed contributed to repetition and omission errors on the prospective memory task (Marsh et al. 2002). Individuals with intellectual disability performed near chance levels on a recognition task based on the performed prospective memory task, which could indicate that retrospective memory capacity is one reason for short delay prospective memory omissions (cf. Kvavilashvili, Messer, and Ebdon 2001). In contrast, individuals with intellectual disability performed better on the long delay prospective memory task than on the short. The short space of time for retrieval or selection of a response on the short delay prospective memory task can have reinforced effects of suboptimal encoding.

Lapses in attention are a plausible contributor to short delay prospective memory omissions. This explanation is supported by: (a) weak and fluctuating working memory performance of individuals with intellectual disability that influenced attentional resources; (b) remarks made by individuals without intellectual disability; and (c) from observations made when the short delay prospective memory task was performed. Specifically, person 1 made associations to non task-related objects in the film, person 2 raised discussions about non task-related topics, person 4 turned his gaze away from the film, and persons 3 and 4 focused on the ongoing task to a degree that is likely to have interfered with the short delay prospective memory task. Inability to shift between tasks (see, for example Kliegel, Ramuschkat, and Martin 2003), attention or intention (see, for example West and Craik 1999) or strategies (see, for example Kliegel et al. 2004), may also have contributed to prospective memory omission errors. Working memory performance of individuals without intellectual disability benefited by switching between strategies (i.e. using the colour of the background in order to discriminate between faces resembling one another in the picture position span task). Difficulties in inhibiting non-beneficial transfer contributed to mixing up prospective memory cues and tasks, and to creating self-generated tasks (to which forming implementation intentions contribute, Chasteen, Park, and Schwarz 2001) such as pretending to put on a tie when Laurel was waving with his tie (person 4) or to difficulties selecting the appropriate prospective memory task (i.e. person 3). These examples could imply limitations in executive functions, although self-invented prospective memory tasks could indicate that the individual understood the basic design of the study.

The ongoing task of the present study (to watch a film) and the working memory task were interpreted as requiring significant attentional demand by individuals with intellectual disability. This gains support from person 3 who was surprised by his accomplishments on the short delay prospective memory task, where he watched the whole film. Working memory capacity and conceptual knowledge may have reduced the need for allocation of attentional resources to the prospective memory task for individuals without intellectual disability. Another explanation may be that strategic allocation of attentional monitoring influences the impact of importance instructions (Kliegel et al. 2003). That is, the effect is expected to require working memory capacity, and thus to differ between individuals with different working memory capacity.

Individuals with intellectual disability relied on the strategy of naming each picture aloud in the picture position span task (cf. Brown and Campione 1972; Rosenquist 2001) which interfered with performance on the more demanding working memory task. The working memory performance of person 1 was, on occasion, on a par with the performance of individuals without intellectual disability, for whom talking introduced errors. Person 1 gave quick responses that may have reduced time-based forgetting (Towse, Hitch, and Hutton 2000). Persons 2 and 5 rehearsed the prospective memory tasks and asked in what order the prospective memory cues would occur. Person 5 spontaneously used prospective memory strategies, associating the long delay prospective memory task to other events in her everyday life and imagining herself performing the prospective memory action. Her strategies are in the spirit of current research and interventions aimed at improving prospective memory (cf., Schmidt, Berg, and Deelman 2001). In sum, strategies guide behaviour of individuals with intellectual disability and may either support performance or interfere with task requirements.

Short delay prospective memory and working memory performance of individuals with intellectual disability was below performance of individuals without intellectual disability. However, the groups performed on a par on the long term memory task (recognition). Furthermore, the prospective memory performance of the groups converged when extra cues were provided. That is, the groups performed more equal on the retrospective than on the prospective aspect of prospective memory. Thus, this study suggests that attentional and working memory capacities may exert more influence than long term memory function, on the prospective memory performance of individuals with intellectual disability.Self-rated prospective and retrospective memory did not differ significantly between the groups despite differences in performance on prospective memory and working memory tasks in the present study. The inter-individual differences among those who answered the PRMQ were less prominent than on either the short delay prospective memory task, the recognition task or the working memory tasks (Villa 1998). Poor performance on the recognition task for individuals with intellectual disability proposes that previous memory-failures may be forgotten (that is failure in retrospective memory). A structured everyday life situation that provides the support the individual needs may reduce the number of memory failures.

The PRMQ is less well-suited for use among individuals with intellectual disability, who do not always master the concepts that are used and the number of response alternatives sometimes exceeds their working memory capacity. Self-rating procedures are sensitive to how questions are framed (cf. Hertzog et al. 2000), but they also are sometimes related to objective measures of performance (Maylor 1990). Aspirations, preferences and opportunities for individual choice are linked to self-ratings which may be why individuals without intellectual disability and individuals with intellectual disability make similar ratings (Hensel et al. 2002). That is, the self-rating and the experience of your own performance may depend on whom you consider relevant to compare with as well as to what extent you notice and remember your omissions.

To conclude, group differences were evident on short delay prospective memory, long delay prospective memory, recognition and WM tasks, but not for the self rated memory task. Intra and inter-individual differences were more prominent for individuals with intellectual disability. This was also true for tasks without ceiling effects for individuals without intellectual disability. Furthermore, the results confirm extensive variation in prospective memory ability among individuals with intellectual disability, and improved performance when cues were provided. There was a tendency for individuals with intellectual disability to perform better on prospective memory tasks with a long delay compared to a short delay. Prospective memory ability could be less limited for situations that provide a high degree of contextual support, that allow for the strategy to recruit help, or with a long window of opportunity for execution that impose less demand on optimal allocation of attention. Further investigations in the characteristics of working memory capacity of individuals with intellectual disability and prospective memory could elucidate if similarities in working memory between this group and other special populations are likely to be involved in prospective memory failure.

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