[Araştırma Makalesi / Research Article]

LIFESPAN DEVELOPMENT OF PROSPECTIVE MEMORY

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ABSTRACT
LIFESPAN DEVELOPMENT OF PROSPECTIVE MEMORY

The paper aims to review the development of prospective memory (PM) in lifespan and its cognitive correlates considering childhood, young adulthood and old adulthood. Prospective memory is the ability to remember to carry out plans in the future. It is crucial for daily functioning especially for children so that they become independent of their caregivers. In the first section of this paper, brief description of prospective memory is explained with both everyday scenarios and laboratory tasks (e.g., including time-based and event-based PM studies), along with the proposed models in understanding the mechanisms of the cognitive processes. In the second section of the paper, the involvement of executive functioning (EF) for both children and adults is discussed. Also, the involvement of executive functioning for PM is further discussed along with the proposed frameworks. The third section discusses the prospective memory performance and correlates in older adults. The close relationship between prospective memory, executive functions and working memory is especially found to be pronounced in childhood. More research is needed that might lead the research in prospective memory within a developmental perspective.

Keywords: *Prospective memory, executive functioning, lifespan development*

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YDÜ Sosyal Bilimler Dergisi, C. XV, No. 2, (Ekim 2022)
Geliş Tarihi: 13 Şubat 2021
Kabul Tarihi: 29 Eylül 2022
Bu makaleden alıntı yapmak için: Erciyes, Aktan Aslı (2022, Ekim). Lifespan Development of Prospective Memory. *YDÜ SOSBİLDER*, 15(2), 239-262.

ÖZ

GELECEĞE YÖNELİK BELLEĞİN YAŞAM BOYU GELİŞİMİ

Bu derleme makalesi geleceğe yönelik belleğin çocukluk, yetişkinlik ve yaşlılık bağlamında yaşam boyu gelişim perspektifinde incelenmesi ve bu bellek türünün bilişsel alandaki bağlantılarını incelemeyi hedeflemektedir. Geleceğe yönelik bellek gelecek bir zamanda yapılması planlananları yapmayı hatırlama becerisi olarak ifade edilebilir. Bu bellek özellikle çocukların günlük akışlarını idame etmeleri açısından önem taşımaktadır. Bu sayede çocukların ebeveynlerinden bağımsızlaştıkları düşünülmektedir. Derlemenin birinci bölümünde geleceğe yönelik bellek alanda yürütülmüş hem laboratuvar hem de günlük senaryolardan yola çıkan araştırmalarla (örn., hem zaman-bazlı hem de olay-bazlı çalışmalarla) açıklanmaya çalışılmıştır. İkinci bölümde yönetici işlevlerin geleceğe yönelik bellek ile olan ilişkisi hem çocuklar hem de yetişkinler için değerlendirilmiştir. Ayrıca yönetici işlevlerle geleceğe yönelik bellek arasındaki ilişkiyi açıklayan bilişsel süreçler bu alanda ileri sürülen modeller aracılığıyla ele alınmıştır. Üçüncü bölümde geleceğe yönelik bellek performansının yaşlı yetişkinlerde hangi bilişsel süreçlerle ilgili olduğu açıklanmaya çalışılmıştır. Geleceğe yönelik belleğin özellikle çocukluk döneminde yönetici işlevlerle özellikle de işler bellekle yakın ilişkisi ortaya konmuştur. Son bölüm alanyazında gelecekteki çalışmalara ve alanyazındaki boşlukların irdelenmesine ayrılmıştır. Bu anlamda gelişimsel perspektifte araştırmalar yapılmasını önemine de değinilmiştir.

Anahtar Kelimeler: *Geleceğe yönelik bellek, yönetici işlevler, yaşam boyu gelişim*

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1. Introduction

This paper aims to review developmental path of prospective memory by comparing different age groups on the related subject. In order to achieve this, Web of Science (WoS) database platform was used. The article searched the following keywords: prospective memory, prospective memory development, prospective memory and executive functioning. We limited publication years from 1990 up to date. The search yielded 409 results. From these, the journal papers which included neurodevelopmental disorders such as the Attention-Deficit and Hyperactivity disorder (ADHD), Learning Disabilities (LD) etc. were excluded.

Prospective memory, in simple terms, is the memory for things we are supposed to carry out in future. Keeping dates and appointments in mind, taking cupcakes out of the oven when they are cooked, remembering to give someone a

call are all examples of prospective memory tasks. As the examples suggest, prospective memory is one of the crucial memory types in order to keep up with daily activities. Therefore, prospective memory is highly relevant for everyday activities (Martin, Kliegel and McDaniel, 2003). Prospective memory involves clinical relevance as well as everyday activities such that considerable number of patients report prospective memory problems aside from their major clinical symptoms (Groot, Wilson, Evans and Watson, 2002; Smith, Del Sala, Logie and Maylor, 2000; Fortin, Godbout, & Braun, 2002). On the clinical side, prospective memory is regarded as a core neurocognitive ability that drives our future intentions. In many neurological disorders, including dementia, prospective memory deficits are common and progresses in time. We constantly rely on our memory for future tasks. Our memory helps out as if we have built-in to do lists in our mind (i.e. "mental note"; Sellen et al., 1997: 486) and refers to each and every item before they are due. By this way, we can mentally program our day and plan our future.

Prospective memory is characterized by three properties. First one is duration between the intention of the action to be performed and the time the action is accomplished. The second is the lack of an explicit cue to remind the person to carry out the action. The last one is the fact that person has to stop the ongoing action in order to perform the intended action (Ellis and Kvavilashvili, 2000). As these functions suggest, mental effort that needs to be allocated for these memory processes cannot be underestimated. The first function suggests that one has to keep in mind when to perform the action, and as that increases it puts extra burden on the person that remembers. The second function points to the fact that lack of an explicit cue makes it necessary to actively hold information in mind until it is executed. Finally, the last function suggests that inhibition as to stop ongoing action at the time of activation is also important. Related to this categorization, four phases of prospective memories are proposed: "1. Intention formation, 2. Intention retention, 3. Re-instantiation of intention and 4. Intention execution" (Martin et al., 2003: 195). The first phase, intention formation points to the stage that an idea of an action that is supposed to be performed is formed. Upon the formation of this intention, one has to retain this intention so that at the time of executing the representation will be called upon. Re-instantiation of intention ensures that the intention is actively kept in mind and ready to be called

whenever needed. At the final stage, intention execution is completed, where the person remembers the intention to withhold the ongoing task and moves to execute the one that is already kept in mind.

Related literature on prospective memory points to limited number of studies in children (Ceci, Baker, & Bronfenbrenner, 1988; Ceci & Bronfenbrenner, 1985; Guajardo & Best, 2000; Kerns, 2000; Meacham & Colombo, 1980). Everyday life puts forces on children to remember things to be done in the future, too. Children often are expected to remember to complete homework, brush their teeth, pass on a message to parents etc. Moreover, children's prospective memory attempts were also regarded as a precursor for development of strategies for retrospective remembering (Meacham & Colombo, 1980). Hence, there might be a close relation between children's prospective and retrospective memory, suggesting that these two processes are either having same underlying mechanisms or they might be affecting one another. It is suggested that these two different memory types might be related at the beginning, however within the pace of development they might become unrelated (Guajardo & Best, 2000).

In the relevant literature, two types of prospective memory tasks are used in experimental designs. The first one is the time-based prospective memory which denotes to a memory where a specific time in the future action is expected to be performed, such as birthday of a relative, graduation ceremony, or an appointment to the dentist. Although experimental designs cannot fully mimic the real-world situations, where duration of a laboratory experiment is often too short compared to real life situations, the findings are relevant to everyday life issues. The second type of prospective memory is the event-based prospective memory, which involves remembering to execute the intention when an associated external cue is prevalent. An everyday example could be asking a question about a research topic when seeing the professor who is experienced in the field. Both types of tasks are relevant for naturalistic settings as well as lab settings.

McDaniel and Einstein (1993) propose that, unlike time based prospective memory tasks, event-based prospective memory tasks resemble cued recall tasks such that focusing on target familiarity increased performance for prospective memory and that prospective memory performance correlates with indirect retrospective memory tasks. Varying the importance of prospective memory tasks

show that increased importance has an impact on performance of time-based prospective memory tasks but event-based memory tasks remain unaffected. (Kliegel, Martin, McDaniel and Einstein, 2001). The reason for this difference is the differential reliance of those two types of tasks on strategic processes. Kliegel et al. (2001) concluded that as long as the task requires "strategic allocation of attentional resources" (Kliegel et al., 2001:1), the performance is increased by amplified importance.

One of the earliest experimental studies in the field is by Loftus (1971) where participants were asked to report which state they were born at the end of the experiment (the instruction was given at the beginning of the experiment). Number of intervening questions and presence or absence of a cue was held as a manipulation. It was found that presence of a retrieval cue for the intention (prospective action of stating the state) facilitated recall of the intention. Additionally, as the number of intervening questions has increased, performance in remembering the intention has been dropped.

2. Underlying Mechanisms: Proposed Models for Prospective Memory

Up to date, there are three models in explaining the underlying mechanisms for prospective memory. Before explaining each of them in detail, we will focus on the types of prospective memory which will give a better understanding of the types of mechanisms that are considered. There are two types of tasks used in prospective memory literature, which are also represented in our daily lives. These two types of prospective memory might have different underlying mechanisms such that they rely on either existence of an external cue or not.

Event-based and time-based prospective memory tasks are proposed to have different underlying mechanism such that event-based tasks rely on external cues whereas time-based tasks are internally controlled (Einstein and McDaniel, 1990). For prospective memory tasks and everyday activities, contextual cueing might be one mechanism that aids intentions to come to mind. When there is no contextual cue, then we have to rely on internal mechanism which might make use of "mental notes" (Sellen, Louie, Harris & Wilkins, 1997: 486). Sellen et al. (1997) found that subjects performed better on the place-based (event-based) tasks compared to the time-based tasks due to the contextual cue (the place itself). As data from the interviews indicate, subjects needed to think less about the place-

tasks compared to time-tasks implying that the presence of a contextual cue might have taken the load to keep the intention in mind at all times. Another important finding is that subjects reported that they were engaged with thinking about the intention more in the time-task compared to the place-task. The following section will focus on three models that explain the underlying mechanisms of prospective memory: (1) Multiprocess framework (2) Preparatory Attentional Model and (3) Reflexive-associative theory.

In their multiprocess framework, McDaniel and Einstein (2000) discuss two alternatives to explain how remembering occurs at the time of intention execution, in other words they explain prospective memory retrieval processes. First one is monitoring the environment (strategic processing) for realization of intention. This process is suggested to be mediated by executive attentional system ("SAS – supervisory attention system", (Shallice & Burgess, 1991). SAS monitors the environment so that one can take act when the time to execute the intention comes to interrupt the ongoing activity. Smith (2003) proposed a modified model in order to explain prospective memory mechanisms. In the preparatory attentional and memory processes (PAM) model, key component is the monitoring of the prospective cue from the environment. Difference between the multi-process model and the PAM model is the weight and importance given to automatic processes. Two views both put equivalent emphasis on controlled processes and on individual differences in explaining performance differences (Smith and Bayen, 2004).

Relatedly, preparatory attentional model (PAM; Smith & Bayen, 2004) predict that working memory plays a large role in prospective memory. The PAM model puts forth that working memory processes work in order to detect the relevant cue, upon which action will be performed. On the other hand, multiprocess framework suggests that those processes are only activated under cognitive load such as low cue salience for prospective memory. Although the mechanisms do not suggest the same route for the two models, the two models agree upon the essential role of executive function processes in prospective memory tasks. One of the most promising candidates of those functions are working memory, which supports monitoring and updating the relevant information that are related to both the ongoing task that should be stopped and

prospective memory task that should be initiated at the appropriate time (Kliegel, Martin, McDaniel & Einstein, 2002).

One other theory that explains underlying mechanisms is reflexive-associative theory. This theory has been put forth by Einstein and McDaniel (2000) and it suggests that when people form an intention for a prospective action, they form an associative link with cue and the intended action. When that cue occurs, the associative-memory system makes it possible for the person to initiate the intended action by bringing it back to consciousness. This indicates that as target cue occurs, the intention to perform the action will occur regardless of the fact that intention is consciously deliberated or not. What makes it different than the other two models is that the theory relies predominantly on the cue availability but not on the other characteristics.

Another explanation of retrieval processes in prospective memory is that the process is automatic. Here the person relies on external conditions in the environment "almost automatically" (automatic processing) for re-instantiation of intention (Guynn, McDaniel and Einstein, 1998). The system engages in deliberate recollection when an external cue automatically triggers the memory trace of the previously encoded intention. If the cue is powerful enough and triggers the system, the system is activated to initiate the execution which means that the ongoing action is stopped and the alternative planned action is undertaken. By this way, few cognitive resources are involved and depleted. Compared to this automatic processing approach, strategic processing is more of resource demanding. McDaniel and Einstein's (2000) proposed multi-process framework considers properties of prospective memory task, cue type, ongoing activity and individual per se. According to their framework, prospective memory can both involve automatic and strategic processes. The importance of the prospective memory task plays a crucial role such that as perceived importance increases so does the performance in prospective remembering. (Andrzejewski, Moore, Corvette and Hermann, 1991; Kvavilashvili, 1987).

Another important aspect is the characteristics of the memory cues. As the target cues are highly distinctive and associable with the intended action, prospective memory performance in enhanced. (Einstein et al., 2000; McDaniel and Einstein, 1993, Guynn et al, 1998). Last but not the least, the properties of the ongoing task affect the performance. If the ongoing task promotes automatic

processing rather than strategic processing, resources are not depleted so that it becomes easy to succeed. However, when the ongoing task does not promote automatic processing then individual differences in attentional resources play a role in determining the performance. Since strategic processing relies more on attentional resources, individuals with greater attentional resources are keener on tasks, and activities. Moreover, aside from cognitive components such as attentional mechanisms, Goschke and Kuhl (1993) suggest that as a personality trait some people may keep their intentions in mind more active compared to others. They propose that people with "active orientation" (which refers to people with capacity to regulate emotions, thoughts and behaviors to execute their intentions) are less inclined to keep intentions of to-do actions in mind compared to the ones with "state orientation" (which refers to people without the above-mentioned capacity). People with state orientation ruminate more about current concerns and that helps them to keep non-executed actions in mind.

3. Development of Prospective Memory, Executive Functioning and Relations to Aging Prospective Memory in Childhood

Prospective memory activities and everyday tasks require a certain level of cognitive competence in order to achieve the desired end which is being able to execute the intended action at the desired time, place and circumstances (Mahy and Moses, 2011). Executive functioning is shown to have special importance in development of prospective memory. (Atance and Jackson, 2009; Mackinlay, Kliegel and Mäntylä, 2009; Rendell, Vella, Kliegel and Terrett, 2009; Wang, Kliegel, Liu and Yang, 2008). The development of prospective memory in childhood is often suggested to be closely related to working memory development. This is evidenced by several lines of findings from the literature. First, the theoretical frameworks, both the multiprocess framework by McDaniel & Einstein (2000), as well as the Preparatory Attentional Model (PAM) point to these controlled processes. Second, the literature suggests that developmental trajectories for prospective memory and working memory often overlap (or a review see Pickering, 2001). Third, correlational studies within childhood show close relationship between the two constructs. For instance, in 6- to 12-year-old children prospective memory was found to be related with visual working memory capacities as well as updating performance (Kerns, 2000). Relatedly, for

children aged from 8- to 12-year-old, working memory performance was a significant predictor of prospective memory above and beyond age. Finally, studies show that for younger children aged between 4- to 6, there was a positive association between backward digit span tests and prospective memory performance. Overall, evidence suggests that working memory and prospective memory are highly related, however it is not clear whether which one is derived from the other.

One of the earliest and influential naturalistic studies that involved children in the area of prospective memory literature is implemented by Ceci and Bronfenbrenner (1985). They investigated children's (10 to 14 years of age) clock checking and monitoring patterns on a prospective memory task, which involved cooking cupcakes. Children were either tested at lab setting or at their homes. It was expected that setting would have an influence on the results, with home setting yielding more time monitoring compared to lab setting. Therefore, the setting was taken as an independent variable. The results of the study had implications both in the developmental perspective and also for theorizing time-based prospective memory for childhood as well adulthood. One experimental study has manipulated working memory in order to show the effects of working memory on prospective memory performance. Mahy and Moses (2011) assigned 4- to 6-year-old children either one or two intentions to carry out. Results indicated that the number of intentions had no effects on prospective memory performance. However, this null result is not replicated and might be due to other factors. On the other hand, adult experimental studies, suggest that working memory capacity has a considerable effect on prospective memory performance (Kidder, Park, Hertzog, & Morrell, 1997).

Some of the key components of executive functioning that might be related to prospective memory are planning, monitoring, working memory and inhibitory control (West & Craik, 1999). Studies on the development of executive functioning showed that between ages 3 to 5 extensive improvements occur in cognitive flexibility (Diamond, 2002; Zelazo, Reznick & Pinon, 1995; Zelazo, Frye & Rapus, 1996). Atance & Jackson (2009) found age related increases in both executive functioning tasks (treat delay, Tower of Hanoi, truck loading) and prospective memory tasks (card in basket and puppet retrieval) in 4- and 5-year-olds. Prospective memory tasks tapped both on time based (puppet retrieval:

children were prompted to remind experimenter to give her/him the puppet at the end of the session) and event-based (card in basket: children were instructed to put the card in basket whenever they saw a special sign) types. Mahy & Moses (2011) also investigated preschoolers' performance for prospective memory in relation to executive functioning. For this purpose, children aged 4 to 6 were tested on one prospective memory and two executive functioning tasks (working memory and inhibitory control tasks). Prospective memory required children to interrupt an ongoing card game to achieve 'single intention' or 'dual intention' with either short delay (1 minute) or long delay (5 minutes). As number of intentions and duration of delay increased, the performance was diminished. After controlling the age, working memory predicted prospective memory performance, however inhibitory control was not a significant predictor. A more recent study shows that there are age-related increases in prospective memory performance across the childhood (Zuber et al., 2019). Working memory updating load had a negative effect on prospective memory performance for older children (10- to 14-year-olds), but the effect was smaller in younger children (5- to 9-year-olds). Hence, processes in children's prospective memory may undergo a shift from simple monitoring behavior to more strategic monitoring behavior that rely on working memory updating processes.

In the same vein, Mackinlay et al. (2009) investigated predictors of time-based prospective memory in children of ages between 7 to 12. Children were tested on a prospective memory task where accuracy, ongoing task performance and monitoring of time were measured. The ongoing task involved one-back picture task with time-based prospective memory task. Children were asked to detect whether the current picture was the same with preceding picture (pictures composed of line drawings of familiar objects) with yes/no response and at the same time instructed to press a key for every 2 minutes passed. For cognitive competence measures, planning, working memory and task switching abilities were tested. The results revealed that time-based prospective memory performance increased with age even when ongoing task performance was controlled. Children were analyzed in two groups as younger (7-9) and older (10-12) and it was found that older children showed greater performance in monitoring tasks as well as prospective memory tasks. Regression analysis revealed that variance in time-based prospective memory tasks due to age was

explained by cognitive competence. It was also found that individual differences in planning and task switching as well as age differences were predictors in time-based prospective memory performance.

A recent study by Zuber et al. (2019) investigated how executive functions are related to time- and event-based prospective memory in school-aged children. The study examined differential input of three executive functions (updating, inhibition and shifting) with different prospective memory tasks (i.e., focal, nonfocal and time-based). Results indicated that age did not predict the prospective memory performance on all task types. However, updating ability was a significant predictor in explaining how well children performed on focal, nonfocal and time-based tasks. Results showed that inhibition and updating predicted focal prospective memory performance. This finding is in line with multiprocess framework that being aware of focal cues were related to low-level processes and therefore would not call for attentional control. The most cognitive load children have to put into effort is when they plan and execute the prospective memory task, that is why updating resources are found to be the best indicator of the performance. In other words, updating resources may be allocated for prospective actions as well as keeping up with the ongoing task. Inhibitory control is found to be related with interrupting the ongoing task and start the new task (i.e., the prospective memory task). Results also indicated that shifting was not a significant predictor for time-based performance.

Overall, literature indicates that time-based prospective memory develops from preschool to adolescence. The maturation of working memory updating function seems to be linked with improvements in prospective memory performance. Results also indicate that younger children might be relying on controlled processes and on the other hand older ones might have relied on automatic processes. Future research might also shed light on other executive functions such as attentional control, planning as well as resource allocation abilities for children.

Prospective Memory and Aging. The effect of executive functioning in understanding life-span development of prospective memory is evident. When aging is considered, many studies have found a performance decline in prospective memory both in event and time-based forms in older adults compared to younger ones (Park et al., 1997; Rendell and Craik, 2000; West, Jakubek and

Wymbs, 2002; Einstein, Smith, McDaniel and Shaw; 1997). However, there are also studies which found no age-related decline (Einstein and McDaniel, 1990; Einstein et al., 1995). Age related differences are more pronounced in time-based prospective memory tasks compared to event-based memory tasks. This could be linked to the fact that there is more involvement of self-initiated action in time-based tasks (Henry et al., 2004).

Empirical studies do not point to the fact that older adults are performing worse than younger adults in all aspects of prospective memory. For instance, older adults are found to perform as their younger counterparts for time-based prospective memory tasks in naturalistic settings as well as laboratory settings. These tasks include phoning an experimenter at a specific time over 4 weeks, mail postcards, and log in an electronic organizer with certain intervals (Devolder, Brigham, & Pressley, 1990; Poon & Schaffer, 1982; Rendell & Thomson, 1993, Sawyer, 1988). On the other hand, young and old adults may differ in their motivation to complete the prospective memory tasks. It is common that old adults are able to set up external cues as they tend to report more everyday memory failures. Unlike naturalistic studies, lab studies of prospective memory point to inconsistent results. Most lab experiments report that older adults perform worse than young adults (Cherry et al., 2001; Kidder, Park, Hertzog, & Morrell, 1997; Mäntylä & Nilsson, 1997; Maylor, 1996; West & Covell, 2001) but there are also studies that suggest otherwise (Einstein et al., 1995; Li & Blackburn, 1994).

In their meta-analytical review, Henry et al. (2004) investigated 26 studies published from 1986 to 2001 with the theme of prospective memory and aging. The results revealed that lab studies yielded more substantial age-related deficits compared to naturalistic designs. In fact, in some studies where naturalistic approach has been carried out, the advantage was not observed (Phillips, MacLeod & Kliegel, 2005). It was found that event-based prospective memory tasks which required high strategic control yielded larger age deficits. McDaniel and Einstein (2000) proposed four factors that may increase age-related deficits in event-based prospective memory tasks due to the increase in task demands: "(a) non-distinctive cues (b) weak association between the cue and the action (c) high attention-demanding ongoing task or (d) processing of the PM cue being peripheral to the ongoing task" (Henry et al., 2004: 28).

Martin et al. (2003) investigated the effects of executive functioning on prospective memory task performance by manipulating task difficulty and nature. Four different prospective memory tasks were implemented a single-task paradigm, two more complex tasks (one time-based, one event-based) and a highly demanding multi-task paradigm. For assessing executive functioning, Wisconsin Card Sorting Test, Stroop and Tower of London were used. The multi-task prospective memory paradigm (Kliegel, McDaniel & Einstein, 2000) involved six subtasks in three phases (1st introduction phase where participants were required to make planning about prospective memory task, 2nd delay phase where participants filled out demographic form for personal information and tested on executive functioning tasks, 3rd a performance phase where multitask prospective task is executed). There were two sets (sets A and B) of three tasks (word finding, arithmetic problems and writing down names of pictures) to be completed in 6 minutes. The dependent variables were the number of subtasks initiated, and the percentage of the recall of participants' original plan (they were asked about the plans they did in phase 1 during debriefing). Event-based prospective memory paradigm involved a computerized word rating task as an ongoing task; memory task was to press a certain key when a certain word was seen on screen. For the time-based prospective memory task, participants were asked to give a personal belonging to the experimenter and to remind to give it back at the end of the session. Results showed that executive functioning did not predict simple single-task prospective memory task performance; but in complex forms of these tasks (event and time-based prospective memory tasks), executive functioning, not age, predicted performance. In multi-task paradigm both executive functioning and age were significant predictors. As a result, it was found that executive functioning measured as planning abilities in TOL and inhibition both predicted prospective memory performances.

Schnitzspahn et al. (2011) tried to resolve the age-related benefits in naturalistic prospective memory tasks and deficits in laboratory tasks via measuring motivation, metacognitive awareness, and activity absorption which is measured as self-rating of perceived stress during morning and afternoon for naturalistic tasks. Older adults performed better in naturalistic tasks and younger subjects performed better in lab tasks. The results are in line with Phillips et al.'s (2008) suggested mechanism that age-related benefit in naturalistic tasks were

related to motivation and metacognitive self-assessment of prospective memory task performance. Thus, when daily activity absorption was taken as a covariate, the age-related differences disappeared. Therefore, the age differences evident in prospective memory tasks show differences based on the task at hand. This finding calls for a closer look at the external factor that might be contributing to overall prospective memory performance.

In a recent empirical study, Smith and Hunt (2014) investigated whether ongoing task load and importance have an effect on performance in prospective memory task in both young and old adults. Task emphasis manipulation was implemented to change importance of tasks in the eyes of the participants. Regardless of the importance manipulation (either on ongoing task or prospective memory task), older subjects performed worse than young adults, even when they perform equally well on the ongoing task. It was concluded that these age-related differences were actually differences "in remembering that something needs to be done rather than in remembering when or what needs to be done" (Smith & Hunt, 2014: 427).

Overall, a recent and comprehensive framework that is provided by Mahy et al. (2014; 2022) points to the importance of executive functioning. The main argument lies in the fact that although retrospective memory is central, it is not sufficient to support prospective memory. According to the model, executive functioning is the locomotive in development of prospective memory in preschool years. The model proposes that first retrospective memory has to be developed then executive functioning supports the prospective memory, inhibition, switching as well as working memory takes important roles in the process. For instance, recent studies show that both event-based and time-based prospective memory improve in middle childhood (ages 7 to 12) (Kerns, 2000; Yang, et al., 2011; Zhao et al., 2019) partly as a consequence the enhanced perception of time.

4. Conclusion & Future Directions

Prospective memory is a fruitful area in understanding the development of cognitive processes such as monitoring and planning throughout life. Within the adult literature, with the help of imaging techniques, neural correlates of prospective memory and related mechanisms, in which individual differences were also investigated (Brigham, 2005; West, Bowry & Krompinger, 2006; West

& Krompinger, 2005). The close relationship between prospective memory and working memory and practical implications that involve everyday life makes it necessary to invest in the area. Any intervention that aims to enhance working memory and updating abilities might also have positive outcomes for prospective memory abilities that have huge projections in our daily lives.

Although the number of studies in the area has increased dramatically from 1986 to 2000 (approximately 180), the percentage of developmental studies have dropped drastically (from 40% to 3%) (Kvavilashvili, Kyle & Messer, 2008). This change is tied to the fact that from 1990's onwards, the developmental line of research has shifted their attention to research on other areas such as false belief, eyewitness testimony, and autobiographical memory and so on. Another reason might be the fact that methodological difficulties such as finding suitable tasks and methods are more pronounced in children's studies (Kvavilashvili et al. 2008). Developmental correlates of prospective memory are often tied to working memory and executive functioning development having emphasis on monitoring and planning. One future consideration might be related to metacognitive abilities of children on both prospective and retrospective tasks. It was found that 5-year-old participants were able to predict their performance on a simple prospective memory task but failed to do so, on a retrospective memory task which involved remembering ten drawings (Kvavilashvili & Mandler, 2004). It is interesting that same difference was not found in adults (McDonald-Miszczak, Gould & Tychynski, 1999). Metacognitive abilities might also be linked to theory of mind abilities in early childhood. Theory of mind might also be related to prospective memory abilities in childhood with the idea of updating what is already known in mind might have projections on prospective memory performance.

Future research should address metacognitive involvement of prospective memory remembering in relations to retrospective remembering in both adults and children. When developmental research is considered, methodological issues in both naturalistic and laboratory tasks should be given close consideration. As the nature of prospective memory paradigm involves switching back and forth from the ongoing task to the target task and vice versa, special populations such as bilinguals could also be tested. While working memory is found to be influential on prospective memory performance with underlying updating mechanism, the advantages linked with bilingualism might be fruitful area to investigate in the

future. More specifically, regarding the underlying mechanisms and proposed models, Smith's (2003) PAM Model and McDaniel & Einstein's (2000) multi-process framework could be expanded to encompass developmental findings that might shed light on theorizing in the area. The literature in bilingualism show that bilinguals are found to be at an advantage when the task at hand involves switching component of executive functions (Bialystok, Craik, Kelin & Viswanathan, 2004; Bialystok, Craik & Ruocca, 2006; Bialystok, Craik & Ryan, 2006). There are also studies which point to advantages of bilingualism at the face of dementia or mild cognitive impairment due to aging (Bialystok, Craik & Ruocca, 2006). However, neither of these studies have focused on prospective memory particularly. Given the importance of prospective memory performance in daily life especially in older adulthood, e.g., not forgetting to take medication, or attending a medical appointment, and given the cognitive benefits associated with bilingualism, the effect of bilingualism on prospective memory should also be addressed.

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