METHODICAL AND THEORETICAL BACKGROUND

RETORE
REMEMBER TO REMEMBER

Co-funded by
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INTRODUCTION

Introduction to the project

As the name Remember to Remember (ReToRe) suggests, the project focuses on the concept of prospective memory. The aim of the project is three-fold. The first part of the aim was to introduce the concept of prospective memory to adolescents and the general public. Second subsequent aim was the development of materials that would enable further advancements of prospective memory including additional development of other 'background' training materials (ongoing tasks, OT) focused on executive functions. Lastly, since metacognition plays a significant role in prospective memory, collection of qualitative information concerning metacognitive strategies used by adolescents was the last part of the project.

Scientific evidence provides support for the importance of training prospective memory especially in adolescence (e.g. Altgassen, Kretschmer, & Schnitzspahn, 2017; Bowman, Cutmore, & Shum, 2015, Schneider, 2010). In the upcoming sections, the concept of prospective memory shall be introduced. Additionally, executive functions and metacognition will be investigated since they play a significant role in the development and functioning of prospective memory. Materials developed for the purpose of the project will be introduced.

Understanding Prospective Memory

Prospective memory (PM) is the ability to remember to perform an action at the appropriate time in the future (Rummel & Kvavilashvili, 2023). This memory type contrasts with retrospective memory, which involves recalling past events or facts. Prospective memory plays a key role in everyday activities, including remembering to attend appointments, finish assignments, or call a friend at a scheduled time (Dismukes, 2012). The manifestations of prospective memory impairment may vary because all memory tasks that are associated with frontal lobe function depend on spontaneous formation of an effective strategy (Umeda et al., 2011). Prospective memory problems account for more than half of our everyday memory problems. In adolescence, the capacity to manage future intentions is critical for academic success, social interactions, and personal development (Guo et al., 2023).

Prospective memory in adolescence

Research highlights the critical role of prospective memory in adolescence. Adolescents are at a pivotal stage in cognitive development, during which their ability to manage future intentions is maturing. Studies have shown that prospective memory is vital for managing the demands of school, home life, and social environments (e.g. Altgassen, Kretschmer, & Schnitzspahn, 2017; Bowman, Cutmore, & Shum, 2015).

McDaniel and Einstein (2000) distinguish two types of prospective memory: event-based (remembering to perform an action when a specific cue occurs) and time-based (remembering to execute an intention at a specific time). Both types are necessary for adolescents, especially in an educational setting, where they must manage multiple assignments, deadlines, and extracurricular activities.

Research by Cheng et al. (2012) indicates that prospective memory can be trained effectively through practice and that this training has significant implications for improving self-regulation and executive functions (working

memory, attention etc.). Adolescents with well-developed prospective memory abilities are better able to manage time, prioritize tasks, and switch between different activities, all of which are essential for academic success and social functioning.

When planning training sessions in the ReToRe project, a combination of both training strategies was adopted (Hering et al, 2014). Prospective memory training often took place through a hands-on practice of various prospective tasks. Participants were given various prospective tasks during group sessions, but also through homework.

When creating the prospective tasks, emphasis was placed on their connection to everyday life of older school-aged children (solving situations at school or during free time). For prospective tasks, the basic process consisted of four phases:

1. Forming and encoding an intention.
2. Postponing the intention while dealing with another (ongoing) task (OT).
3. Inhibiting and switching from the OT to resuming the intention at an appropriate/planned time in the future.
4. Intention execution.

In the context of the ReToRe project, prospective memory is a central focus because it directly influences how adolescents plan, execute, and manage tasks. The ability to remember and execute intentions at the right time underpins many academic and personal responsibilities, such as remembering to complete homework assignments, attending after-school events, or fulfilling social obligations.

Understanding executive functions

In the broadest sense, executive functions refer to those abilities that enable us to adapt flexibly to changing conditions and to move from one situation to another (Lezak, Howieson, & Loring, 2012). In a narrower sense, it is an umbrella term for abilities that include planning, problem solving, working memory, inhibition, shifting or changing settings, switching attention from one task to another, cognitive flexibility, initiating action and organizing the course of action, updating or tracking and encoding incoming relevant information and replacing irrelevant information with new, relevant information, and monitoring or continuously monitoring one's own cognitive performance (Gaál, 2011; Koukolík, 2012). The executive function training materials draw on the division of executive functions given above and the working memory model of Baddley and Hitch (1974).

Working memory refers to the brain's capacity for short-term abstraction and manipulation of information and is a fundamental neurocognitive process in various aspects of everyday functioning (Owens, Duda, 2018). Working memory lies at the boundary between executive functions and memory, and its smooth, integrative progression is essential in everyday life (Rodriguez, 2017). Baddeley and Hitch's (1974) original model divides working memory into systems that are used to store information, namely the phonological loop and the visuospatial sketchpad. The main part of this model is the central executive whose task is to coordinate the two systems mentioned above and to coordinate and access information from and to long-term memory (Czop and Heretik, 2016). In 2000, Baddeley extended the original model to include an additional component, the episodic stack The revised working memory model (Figure 1) thus provides a better basis for addressing more complex aspects of executive control in working memory (Baddeley, 2000).

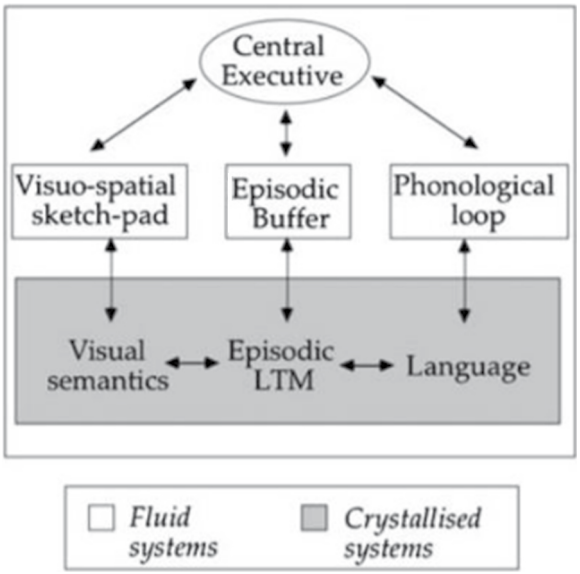


Figure 1: Baddeley's model of working memory (Baddley, 2012)

Difficulty in executive function has a significant impact on quality of life, particularly on independence (Lezak, Howieson, & Loring, 2012). In addition, Fillingham et al. (2006) also state that intact working memory and executive function reflect the ability to learn in the therapeutic process. Studies across different age categories speak in favour of significant effects of working memory training and the possibility of significant transfer to untrained tasks (Strobach, Karbach, 2021). The observed effects of working memory training could be particularly useful for individuals for whom low working memory capacity is limiting in academic performance and everyday life (Klinberg, 2010). According to Owens and Duda (2018), working memory training improves performance on working memory tasks and also increases the activity of the executive neural network for working memory. The observed effects of working memory training could be particularly useful for individuals for whom low working memory capacity is limiting in academic performance and everyday life (Klinberg, 2010). According to Owens and Duda (2018), working memory training improves performance on working memory tasks and also increases the activity of the executive neural network for working memory. These functions are also essential for functional communication, as communication is largely based on the process of initiation, problem solving, monitoring, and changing mental settings (shifting) in terms of executive function components.

Importance of executive functions in adolescence

Research consistently highlights the importance of executive functions in adolescent development. Lezak et al. (2012) emphasize that executive functions play a pivotal role in adapting flexibly to new situations and challenges. Adolescents with impaired executive functions often experience difficulties in managing academic workloads, navigating social relationships, and making responsible decisions.

A study by Fillingham et al. (2006) found that well-developed executive functions, particularly working memory, and inhibitory control, are strongly correlated with academic performance. Similarly, Klingberg (2010) and Owens and Duda (2018) suggest that training working memory and other executive functions can have a significant impact on improving cognitive control and academic achievement.

The role of metacognition

Metacognition involves thinking about one's thinking, including the awareness and control of one's cognitive processes. Adolescents with strong metacognitive abilities are better able to reflect on their learning, identify strategies that work for them, and regulate their cognitive behaviour. As they approach more complex tasks, they can assess what strategies might be most effective and adjust their approach accordingly.

Metacognitive development in adolescence

Research has shown that metacognition develops throughout childhood and adolescence, reaching greater sophistication in the teenage years. Adolescents with well-developed metacognitive skills are more likely to employ effective learning strategies, assess their performance critically, and adjust their approaches based on reflection and feedback (Schraw & Dennison, 1994). Metacognitive awareness is linked to academic success, as adolescents who monitor their own learning and adjust their strategies tend to perform better in school and demonstrate higher levels of problem-solving ability (Veenman et al., 2006). By improving metacognitive skills, adolescents can better regulate their prospective memory and executive functions, ultimately leading to more effective decision-making, planning, and task execution. In the ReToRe project, training materials are designed to help adolescents reflect on their thinking, evaluate their progress, and adjust their strategies as needed. An important part of the training is the reflection on the prospective tasks and self-reflection on cognitive processes, which is done by means of a self-assessment protocol that is filled in after each lesson.

The ReToRe project integrates prospective memory, executive functions, and metacognition into a holistic training approach. Children engage in tasks that require them to plan for future actions, manage cognitive resources, and reflect on their strategies. By combining these cognitive domains, the project helps children develop the skills they need to navigate both present and future demands effectively. The tasks developed as part of the project are described in the following section.

Tasks and materials

Tasks targeting prospective memory

The ReToRe project integrates prospective memory tasks designed to engage both event-based and time-based memory. The tasks are structured to mirror real-life situations where children need to remember to perform actions in the future.

An example of a prospective memory task used in the project:

Prospective Task I:

1. **Task preparation:** The administrator prepares an assignment consisting of a client sheet, map (Figure 3), playing pieces, and worksheets themed around different life scenarios such as Pharmacy, Helping a friend, and Cinema. These scenarios reflect realistic situations adolescents encounter in their everyday lives.
2. **Introduction:** The participant reads the assignment, and the administrator ensures that the task is clearly understood. Afterward, the administrator assigns background tasks that focus on executive functions.
3. **Task execution:** During the background tasks, the participant is prompted by a green circle symbol displayed on the screen. This symbol serves as a cue for the adolescent to shift their focus to the

prospective memory task. The participant must place the figure on the map at the appropriate location and select the corresponding image from the worksheet.

4. **Return to background tasks:** After completing the prospective task, the participant returns to the background executive function tasks, allowing the practice of task switching and other cognitive processes.

Figure 3. A map of situations used in the Prospective Memory tasks

When constructing tasks for event – based or time-based PM, additional task parameters were followed (McDaniel and Einstein, 2007):

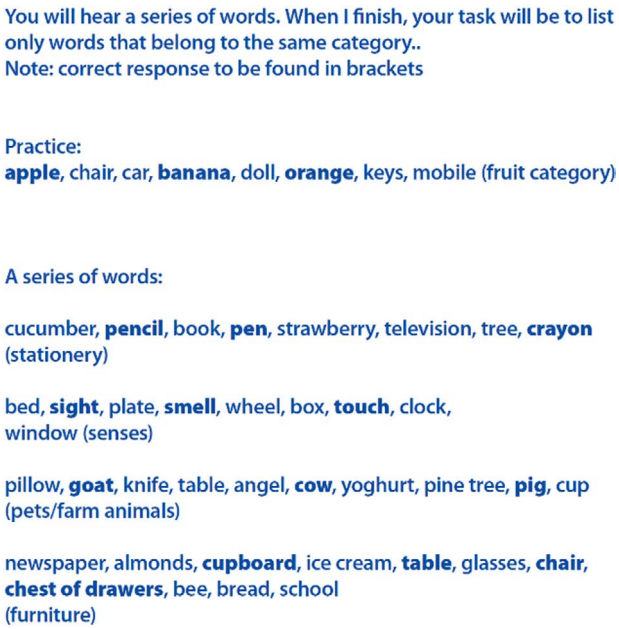
1. Delayed implementation of the plan.
2. The role of prospective memory is embedded in an ongoing activity.
3. The window for initiating an intent is limited.
4. The time scale for the implementation of the project is limited.
5. The intention (intent) must be present.

The tasks were designed to challenge both event – based and time – based prospective memory, thus helping participants develop the ability to recall intentions at the appropriate moment, whether triggered by an external event or by an internal time cue.

Tasks targeting executive functions

In the ReToRe project, executive function tasks were designed to enhance adolescents' working memory, cognitive flexibility, and inhibitory control, thereby fostering improved performance in both academic tasks and daily life activities. The individual tasks are based on the above mentioned theory and their design was further inspired by publications for training memory and cognitive functions in general, e.g. Klucká & Volfová (2009), Bednářová (2015, 2021, 2022). Various mobile apps and computer programs for memory and working memory training served as additional inspiration. Knowledge about test tasks from diagnostic tests designed for clinical diagnosis of memory, attention and executive functions also played a role in developing the tasks (e.g., the Stroop test or the so-called n-back tests, the d2 attention test or the Trail making test). Lastly, exercises which had been developed by students Alžběta Dubská, Helena Sobieská, Amálie Jahodová, Veronika Polášková and Michaela Myslíková in diploma theses, under the guidance of Mgr. Lucie Kytnarová, Ph.D., were incorporated. For an example of a task focused on working memory, more specifically its component called phological loop, see Figure 3.

Based on discussions with experts and project partners, 6 areas were selected for practicing executive functions, which served as so-called ongoing tasks in the training sessions.


You will hear a series of words. When I finish, your task will be to list only words that belong to the same category..
Note: correct response to be found in brackets

Practice:
apple, chair, car, **banana**, doll, **orange**, keys, mobile (fruit category)

A series of words:

cucumber, **pencil**, book, **pen**, strawberry, television, tree, **crayon** (stationery)

bed, **sight**, plate, **smell**, wheel, box, **touch**, clock, window (senses)

pillow, **goat**, knife, table, angel, **cow**, yoghurt, pine tree, **pig**, cup (pets/farm animals)

newspaper, almonds, **cupboard**, ice cream, **table**, glasses, **chair**, **chest of drawers**, bee, bread, school (furniture)

Figure 3. Example task focused on phonological loop.

Training Procedures and Implementation

Each session is organised in the same way. Before each session, the room and materials is prepared. There is no clock in the room, therefore, participants could monitor the time on the administrator's phone, with the set time serving as a cue for the prospective memory task. After participants arrived, an accepting atmosphere is created for the adolescents to feel comfortable. A topic of the session is presented with an introduction to the present executive function covered. Children are asked about real-life examples of using certain function to ensure their understanding. Subsequently, a story from the Prospective Memory set of tasks is read. When waiting for cues, children participated in the Ongoing Tasks covering executive functions. After each training, participants answer questions regarding metacognition, e.g. what strategies they used to succeed in the tasks, what they could do next time etc. To complete the answers and self-awareness in the area of metacognition, the self-evaluation questionnaire (Figure 4).

Since the training is organised as a group training, participants could benefit from the company of others and gain further inspiration in terms of other metacognitive strategies applied by their peers.

The organisation of individual training sessions also depends on the abilities and possibilities of the participants. If the tasks take participants with disabilities longer to complete, the tasks are divided into multiple sessions and the work is individually tailored.

At the end of each session, participants are given optional homework tasks. These tasks encouraged independent prospective memory practice until the next session. Moreover, since the tasks served mainly as an inspiration and participants were asked to invent their own homework tasks, children's creativity was also encouraged.

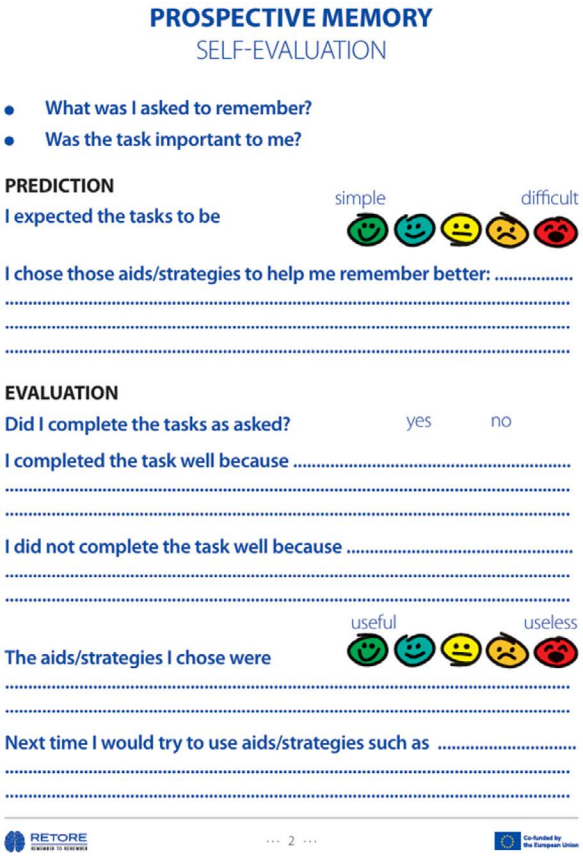


Figure 4. Self-evaluation Questionnaire

Materials for training prospective memory and executive functions in the Remember To Remember project:

- RETORE-worksheet-EN-Self-evaluation.pdf
- RETORE-worksheet-EN-Homework.pdf
- RETORE-worksheet-EN-Administrator-instructions.pdf
- RETORE-worksheet-1-EN-Colors.pdf
- RETORE-worksheet-2-EN-Cancellation.pdf
- RETORE-worksheet-3-EN-Working-Memory-Phonological-Loop.pdf
- RETORE-worksheet-4-EN-Working-Memory-Visuospatial-Sketchpad.pdf
- RETORE-worksheet-5-EN-Working-Memory-Episodic-Buffer.pdf
- RETORE-worksheet-6-EN-Inhibition.pdf
- RETORE-worksheet-EN-Prospective-memory-1.pdf
- RETORE-worksheet-EN-Prospective-memory-2.pdf
- RETORE-worksheet-EN-Prospective-memory-3.pdf
- RETORE-worksheet-EN-Prospective-memory-4.pdf
- RETORE-worksheet-EN-Prospective-memory-5.pdf

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