

PhD School in Psychology

Department of Cognitive Science

Budapest University of Technology and Economics



**THE VULNERABLE NATURE OF AUTOBIOGRAPHICAL MEMORY:
PRECLINICAL DEPRESSIVE SYMPTOMS, PATHOLOGICAL AND NORMAL AGING, AND TIME OF
DAY EFFECTS IN AUTOBIOGRAPHICAL REMEMBERING**

PhD Thesis Booklet

Ágnes Szöllősi

Supervisor: Dr. Mihály Racsmány

2016

Budapest, Hungary

INTRODUCTION AND THEORETICAL BACKGROUND

Originally, *episodic memory* has been conceptualized as a memory system (or memory domain) that is responsible for the conscious retrieval of past events (Tulving, 1972). From this perspective, the concept of episodic memory is that of *autobiographical memory*: a collection of personally experienced life events. However, we have good reasons to make a clear distinction between episodic and autobiographical memory. Whereas episodic memory always represents unique events (Tulving, 1972, 1983, 1985), autobiographical memory represents not only event-specific (episodic) details of unique events, but also contains knowledge-based (semantic) information, i.e., autobiographical facts (see e.g., Brewer, 1996; Conway, 1992). Therefore, it clearly follows that although episodic and semantic memory can be conceptualized as two separable systems with their own characteristics, they closely interact with each other in everyday life.

Importantly, based on the results of AM studies, the concept of episodic memory has been elaborated (see Conway, 2001, 2005, 2009). Episodic memories (i.e., specific autobiographical events) represent short time periods and contain highly specific (e.g. contextual) event details. Specific events are mostly represented in the form of images making them distinguishable from autobiographical facts (Brewer, 1996; Rubin, 1996). When images and other event-specific details are accessed, the person has a feeling of the self in the past – a phenomenon termed recollective experience (Brewer, 1996; Conway, 2001, 2005; Tulving, 1985).

It was also suggested that episodic memory is responsible not only for the recollection of past events but also necessary to imagine the future (Tulving, 1985). In fact, individuals recombine event details of autobiographical memories stored in episodic memory when they anticipate future events (see Atance & O'Neill, 2001; Schacter, Addis, Hassabis, Martin, Spreng, & Szpunar, 2012; Schacter & Addis, 2007; Schacter, Addis, & Buckner, 2007). Consequently, autobiographical remembering and 'episodic future thinking' involve similar processes. It should be highlighted, however, that semantic memory is also essential for future thinking as it provides a conceptual basis for the simulation of future episodes (Irish, Addis, Hodges, & Piguet, 2012; Irish & Piguet, 2013). In brief, similarly to the recall of autobiographical memories, semantic memory and episodic memory closely interact when individuals imagine possible future scenarios.

A crucial question is what factors determine the proportion of episodic and semantic contents within autobiographical memories and imagined events. In a selective overview, Cabeza and St. Jacques (2007) specified some important factors that determine the proportion of episodic details within autobiographical memories. First, **event frequency**, i.e., unique events contain more episodic details than repeated events with similar (and interfering) features (for an overview see e.g., Conway, 2005; see also Barsalou, 1988; Conway & Bekerian, 1987). Second, the **mental health of individuals**, i.e., healthy individuals' memories contain more episodic details than those of patients with psychiatric (e.g. depressive) symptoms (see Williams & Broadbent, 1986; Williams, Ellis, Tyers, Healy, Rose, & MacLeod, 1996; Williams & Scott, 1988; Williams, Teasdale, Segal, & Soulsby, 2000) and those of patients with neurological symptoms, such as in Alzheimer's disease (e.g., Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Barnabe, Whitehead, Pilon, Arsenault-Lapierre, & Chertkow, 2012; Irish et al., 2011; Meulenbroek, Rijpkema, Kessels, Rikkert, & Fernández, 2010; Philippi et al., 2012; Sagar, Cohen, Sullivan, Corkin, & Growdon, 1988). Third, the **age of individuals**, i.e., young adults' memories contain more episodic details than those of older individuals (e.g., Addis, Musicaro, Pan, & Schacter, 2010; Addis, Wong, & Schacter, 2008; Borriani, Dall'Ora, Della Sala, Marinelli, & Spinnler, 1989; Cohen, Conway, & Maylor, 1994). Finally, the **age of memories**, i.e., recent memories contain more episodic details than remote memories (e.g., Janssen, Rubin, & St. Jacques, 2011; see also Rubin & Schulkind, 1997).

In sum, we outlined some factors that influence the accessibility of event-specific details of episodic memories. Here we present three studies examining some of the factors described above, namely, interference effects, the mental health of participants (in a subclinical depressive state and in Alzheimer's disease), the age of participants, and the age of memories. What follows is the main objectives of our studies followed by our most important results and some concluding remarks.

MAIN OBJECTIVES AND THESIS POINTS

Thesis 1: The time of reactivation affects the long-term accessibility of autobiographical memories

Previous studies have shown that memory efficiency can fluctuate during wakefulness (Baddeley, Hatter, Scott, & Snashall, 1970; Folkard & Monk, 1978, 1979; Hasher, Chung,

May, & Foong, 2002; Petros, Beckwith, & Anderson, 1990). It seems that long-term memory for laboratory-based study materials (e.g. words) is better when learning occurs at the end of the day, rather than when subjects study in the morning (Barbosa & Albuquerque, 2008; Folkard & Monk, 1978; Gais, Lucas, & Born, 2006). Memory for materials studied in the evening might benefit from the lack of interference effects during sleep (see Jenkins & Dallenbach, 1924; for reviews, see Wixted, 2004, 2005).

Interestingly, no previous study aimed at investigating the possible relationship between the time of day and autobiographical remembering. However, such studies of autobiographical memory could lead to important conclusions not only from a theoretical perspective but also from a practical viewpoint. One of the most frequently used methods in autobiographical memory research is the so-called diary method. In a typical diary study, participants are asked to record memories in a diary either in the morning or at the end of the day. In fact, when participants record events in a diary, memories for those events are reactivated and it is known that reactivated memories are especially sensitive to interference effects (see Nader & Einarsson, 2010; Sara, 2000). Therefore, it is possible that recording events in a diary in the evening, relative to recording in the morning, can have a beneficial impact on the reconsolidation of those memories due to the absence of new upcoming (and potentially interfering) information during sleep. The aim of **Study 1** (Szöllösi, Keresztes, Conway, & Racsomány, 2015; Szöllösi & Racsomány, 2013) was to investigate whether the time of event recording (morning vs. evening) affects the long-term accessibility of AMs.

We investigated young adults who were asked to record autobiographical events for that day or for the previous day in a diary. We also varied the time of event recording: subjects were asked to complete the diary either in the morning or in the evening. Following a 30-day retention interval, we tested participants' memory for the diary events in a free recall task.

Although the time of retrieval did not affect the current memory performance, the time of retrieval had an effect on long-term memory retention. Subjects who recorded their memories in the evening in the first phase of the experiment showed superior long-term memory performance, relative to those subjects who reactivated their memories in the morning.

Our results can be interpreted in the light of relevant findings showing that the lack of interference effects during sleep has a beneficial impact on memory consolidation. Previous studies have shown that when learning occurs at the end of the day it leads to better consolidation of recently formed memories (possibly due to the absence of interference

effects during sleep) resulting in better long-term memory retention (Barbosa & Albuquerque, 2008; Folkard & Monk, 1978; Gais et al., 2006; but see Mather & Knight, 2005). Regarding our study, it can be assumed that participants who completed their diary in the morning continued their daily activities shortly after memory reactivation, and those possibly interfering events could have disrupted the reconsolidation of the reactivated memories rather than when memory reactivation occurred in the evening. According to the best of knowledge, our study is the first to show that the time of reactivation affects the reconsolidation of episodic memories indicating the similarities between the consolidation of recently formed memories and the reconsolidation of reactivated memories.

A list of our findings regarding Thesis 1:

- 1.1. The time of day affects AM.
- 1.2. The time of retrieval shows no relationship with the current accessibility of AMs.
- 1.3. The time of retrieval affects the later accessibility of AMs.

Thesis 2: Preclinical depressive symptom severity is associated with the phenomenal characteristics of imagined events

Several theorists suggest that episodic memory is especially vulnerable and is affected by the mental health of individuals. For example, a long line of studies have demonstrated episodic memory deficit in depression. Individuals with high levels of depressive symptoms differ from healthy controls in terms of autobiographical remembering and of future thinking. When depressive patients are asked either to recall autobiographical memories or to imagine future episodes, they usually fail to access event-specific (episodic) details of positive episodes; instead, they tend to report general (summarized) events that contain knowledge-based (semantic) information rather than episodic details (e.g., MacLeod & Salaminiou, 2001; MacLeod, Tata, Kentish, & Jacobsen, 1997; Williams & Broadbent, 1986; Williams et al., 1996; Williams & Scott, 1988) – a phenomenon termed overgeneralization in depression. Most previous studies focused on the contents of memories and imagined episodes. As a methodological extension, in a study by Stöber (2000), participants were instructed not only to imagine future episodes, but also to rate the imagery of the generated episodes. Results showed that depressive symptom severity was associated with reduced vividness of the imagined positive events (see also Holmes, Lang, Moulds, & Steele, 2008; Morina, Deepro, Pusowski, Schmid, & Holmes, 2011), suggesting that the presence of depressive symptoms is related to the phenomenology of future episodes.

Importantly, the specificity of event details can be measured by ratings of the phenomenal characteristics of both past experiences and imagined episodes (e.g., Johnson, Foley, Suengas, & Raye, 1988). Therefore, in **Study 2** (Szöllősi, Pajkossy, & Racsmány, 2015), we investigated the relationship between the presence of (preclinical) depressive symptoms and a wide range of phenomenological characteristics of imagined future episodes (other than vividness – as previous studies have done).

We investigated individuals who had no history of psychiatric and/or neurological disorders. Participants were instructed to imagine specific future episodes in response to emotionally positive and negative words and to rate the following phenomenological qualities of the events on 7-point scales: (1) vividness, (2) time, (3) location, (4) visual details, (5) sounds, (6) felt, (7) importance, (8) accessibility, and (9) certainty. Depressive symptom severity was assessed with the 13-item version of the Beck Depression Inventory (BDI; Beck & Beck, 1972; Hungarian: Halmai, Dömötör, Balogh, Sárosi, Faludi, & Székely, 2008).

Results of Study 2 replicated the findings of earlier studies (Kosnes, Whelan, O'Donovan, & McHugh, 2013; MacLeod & Conway, 2007; O'Connor, O'Connor, O'Connor, Smallwood, & Miles, 2004), as we showed that non-clinical subjects with more severe preclinical depressive symptoms had difficulty in accessing specific details of imagined positive episodes. It was revealed that depressive symptom severity correlated with reduced access to episodic (contextual and perceptual) details of imagined positive episodes. Furthermore, subjects with higher depression scores rated their positive imageries less vivid, which finding is consistent with previous results on reduced imagery for positive events in depression (Holmes et al., 2008; Morina et al., 2011; Stöber, 2000). Finally, positive events generated by more depressed participants were less positive in tone and were given lower ratings on certainty. For the negative episodes, a different pattern of relationship emerged. Higher depression scores were associated with higher ratings on vividness, time, importance, sounds, and certainty.

Although most previous studies investigated the contents of memories and of future thoughts, investigating a non-clinical sample, we presented results showing that preclinical depressive symptom severity is related to the phenomenology of imagined future episodes.

A list of our findings regarding Thesis 2:

Preclinical depressive symptom severity...

- 2.1. ...is related to the phenomenology of future thinking;

- 2.2. ...is associated with lower ratings of the phenomenological characteristics of imagined positive episodes;
- 2.3. ...is associated with higher ratings of the phenomenological characteristics of imagined negative episodes.

Thesis 3: Reduced access to episodic details in patients with Alzheimer's disease and in healthy older adults

A long line of studies has demonstrated that episodic memory is affected by normal and pathological aging, such as in Alzheimer's disease (for reviews, see e.g., Becker & Overman, 2002; Carlesimo & Oscar-Berman, 1992; Souchay & Moulin, 2008). This episodic memory decline in the healthy elderly and in patients with Alzheimer's disease is due to structural and functional changes in episodic memory-related brain areas, i.e., medial temporal lobe and prefrontal cortical regions (see Bäckman, Almkvist, Andersson, & Nordberg, 1997; Cabeza, Grady, Nyberg, & McIntosh, 1997; Fjell & Walhovd, 2010; Raz, 2004; Reuter-Lorenz, Jonides, Smith, Hartley, Miller, Marshuetz, & Koeppel, 2002). Consequently, a wealth of studies have shown that Alzheimer patients and healthy older individuals have difficulty in accessing episodic details of autobiographical memories.

Patients with Alzheimer's disease have great difficulty in accessing contextual (e.g., details on time and location), sensory-perceptual, and emotional details of personal memories, especially if they try to access details of recently formed memories (Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Barnabe et al., 2012; Irish et al., 2011; Meulenbroek et al., 2010; Philippi et al., 2012; Sagar et al., 1988). Furthermore, investigating the contents of autobiographical events (Addis et al., 2008, 2010; Borroni et al., 1989; Cohen et al., 1994) and the phenomenology of autobiographical remembering (Cohen & Faulkner, 1988; Hashtroudi, Johnson, & Chrosniak, 1990; Piolino, Desgranges, Clarys, Guillery-Girard, Taconnat, Isingrini, & Ustache, 2006; Rathbone, Holmes, Murphy, & Ellis, 2015), most studies reported that there is a decline in memory for episodic details of personal events in healthy older individuals as well. However, it should be highlighted that this age-related memory decline in the healthy elderly is much less severe than in patients with Alzheimer's disease.

In order to validate a widely used interview method, the Autobiographical Interview (Levine, Svoboda, Haye, Winocur, & Moscovitch, 2002), we investigated three healthy age groups (young, middle aged, and older individuals) and a group of patients with Alzheimer's disease (in the early stage of the disease). Participants were required to recall one specific personal memory from each of five lifetime periods. Memory contents were analyzed by

using two standardized scoring procedures. These coding procedures allowed us to separate knowledge-based (semantic) contents from episodic (e.g., contextual and perceptual) details within a single event description.

We found an age-related memory decline in the recall of episodic details of autobiographical memories. Middle-aged individuals' memories contain fewer episodic details relative to those of young adults and more episodic details relative to those of older individuals. Importantly, episodic memory scores differed between young and older adults not only for recent but also for remote memories (i.e., events that occurred in the distant past) suggesting that retrieval is more affected than encoding in healthy individuals. For semantic details, no difference was found. Furthermore, Alzheimer patients showed episodic impairment, relative to the healthy control group, but only for recent memories, and not for the older ones. For semantic details, a different pattern of results could be seen. Patients recalled an increased number of semantic details than healthy subjects, which difference was significant only for temporally distant memories. In sum, an age-related decline could be seen in memory for episodic autobiographical events, and a more severe episodic memory impairment was detected in patients with Alzheimer's disease.

A list of our findings regarding Thesis 3:

- 3.1. Middle-aged individuals' autobiographical memories contain a reduced number of episodic details relative to those of young adults and an increased number of episodic details relative to those of older individuals.
- 3.2. Alzheimer patients' recent memories contain less episodic details than of controls.
- 3.3. Alzheimer patients' temporally distant memories contain more factual (semantic) contents than of controls.

SUMMARY AND GENERAL DISCUSSION

We aimed to investigate episodic memory in a natural context, therefore, we used autobiographical research methods in a line of three experiments to examine the accessibility of episodic memories and of imagined episodes. Importantly, we analyzed not only the contents of autobiographical events but also the subjective state that accompanies episodic retrieval.

Investigating a healthy sample we showed that recalling an autobiographical memory shortly before sleep helps its long-term retention, relative to recalling a memory in the early hours of the day. These results can be explained by the beneficial impact of the lack of interference effects during sleep on the reconsolidation of reactivated memories shortly before sleep (see Nader, 2003; Nader & Einarsson, 2010; Sara, 2000). Furthermore, we provided experimental evidence for the relationship between preclinical depressive symptom severity and the phenomenology of episodic future thinking. Although most previous studies examined the contents of memories (e.g., MacLeod & Salaminiou, 2001; MacLeod et al., 1997; Williams & Broadbent, 1986; Williams et al., 1996, 2000; Williams & Scott, 1988), we showed that overgeneralization in a subclinical depressive state can be measured by self-ratings of imagined episodes. Finally, we showed that how episodic memory can be impaired as the result of pathological and healthy aging. Similarly to previous studies (e.g., Addis et al., 2009, 2010; Levine et al., 2002), using the Autobiographical Interview, a selective episodic memory deficit was detected in patients with Alzheimer's disease and in healthy older individuals with intact capabilities of recalling personal facts.

Importantly, episodic remembering involves *constructive* processes at least to some extent (see Bartlett, 1932; Bransford, Barclay, & Franks, 1972; Brewer, 1988; Conway, 1995; Neisser, 1976; Schank, 1982; Schank & Abelson, 1977; Schacter, Norman, & Koutstaal, 1998). During retrieval, individuals combine elements of autobiographical memories in order to construct their personal past and also to construct possible future scenarios suggesting that episodic memory is highly flexible (see e.g., Schacter et al., 2007, 2012). The flexibility of episodic memory is strongly related to the observation that episodic memories for autobiographical events are greatly affected by various factors operating prior to or at the time of retrieval (see Roediger & Marsh, 2003). Based on our results, we also stress the *vulnerable nature* of episodic autobiographical memory, relative to other forms of memory (e.g. semantic memory).

The dissertation is based on the following works:

- (1) **Szóllósi, Á.**, Keresztes, A., Conway, M. A., & Racsmány, M. (2015). A diary after dinner: how the time of event recording influences later accessibility of diary events. *Quarterly Journal of Experimental Psychology*, 68(11), 2119-2124. doi:10.1080/17470218.2015.1058403 – **Thesis 1**
- (2) **Szóllósi, Á.**, & Racsmány, M. (2013). Time of day has an opposite effect on the generation of past and future events. *Learning and Perception*, 5, 44-45. – **Thesis 1**
- (3) **Szóllósi, Á.**, Pajkossy, P., & Racsmány, M. (2015). Depressive symptoms are associated with the phenomenal characteristics of imagined positive and negative future events. *Applied Cognitive Psychology*, 29(5), 762-767. doi:10.1002/acp.3144 – **Thesis 2**
- (4) **Szóllósi, Á.**, & Kónya, A. (2011). Az önéletrajzi emlékezet vizsgálata: Önéletrajzi Interjú eljárás. *Magyar Pszichológiai Szemle*, 66(4), 587-603 [English title: Research of autobiographical memory: the Autobiographical Interview method]. doi:10.1556/MPSzle.66.2011.4.2 – **Thesis 3**

REFERENCES

- Addis, D. R., Musicaro, R., Pan, L., & Schacter, D. L. (2010). Episodic simulation of past and future events in older adults: evidence from an experimental recombination task. *Psychology and Aging, 25*(2), 369-376.
- Addis, D. R., Sacchetti, D. C., Ally, B. A., Budson, A. E., & Schacter, D. L. (2009). Episodic simulation of future events is impaired in mild Alzheimer's disease. *Neuropsychologia, 47*(12), 2660-2671.
- Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences, 5*(12), 533-539.
- Addis, D. R., Wong, A. T., & Schacter, D. L. (2007). Remembering the past and imagining the future: common and distinct neural substrates during event construction and elaboration. *Neuropsychologia, 45*(7), 1363-1377.
- Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences, 5*(12), 533-539.
- Baddeley, A. D., Hatter, J. E., Scott, D., & Snashall, A. (1970). Memory and time of day. *Quarterly Journal of Experimental Psychology, 22*(4), 605-609.
- Bäckman, L., Jones, S., Berger, A.-K., Laukka, E. J., & Small, B. J. (2005). Cognitive impairment in preclinical Alzheimer's disease: a meta-analysis. *Neuropsychology, 19*(4), 520-531.
- Barbosa, F. F., & Albuquerque, F. S. (2008). Effect of the time-of-day of training on explicit memory. *Brazilian Journal of Medical and Biological Research, 41*(6), 477-481.
- Barnabe, A., Whitehead, V., Pilon, R., Arsenault-Lapierre, G., & Chertkow, H. (2012). Autobiographical memory in mild cognitive impairment and Alzheimer's disease: a comparison between the Levine and Kopelman interview methodologies. *Hippocampus, 22*(9), 1809-1825.
- Barsalou, L. W. (1988). The content and organization of autobiographical memories. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: ecological and traditional approaches to the study of memory* (pp. 193-243). Cambridge: Cambridge University Press.
- Bartlett, F. C. (1932). *Remembering*. Cambridge: Cambridge University Press.
- Beck, A. T., & Beck, R. W. (1972). Screening depressed patients in family practice. A rapid technic. *Postgraduate Medicine, 52*(6), 81-85.

- Becker, J. T., & Overman, A. A. (2002). The memory deficit in Alzheimer's disease. In A. Baddeley, M. D. Kopelman, & B. A. Wilson (Eds.) *The handbook of memory disorders* (pp. 569-589). Chichester: John Wiley & Sons Ltd.
- Borrini, G., Dall'Ora, P., Della Sala, S. Della, Marinelli, L., & Spinnler, H. (1989). Autobiographical memory. Sensitivity to age and education of a standardized enquiry. *Psychological Medicine*, *19*(1), 215-224.
- Bransford, J. D., Barclay, J. R., & Franks, J. J. (1972). Sentence memory: a constructive versus interpretive approach. *Cognitive Psychology*, *3*(2), 193-209.
- Brewer, W. F. (1988). Memory for randomly sampled autobiographical events. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: ecological and traditional approaches to the study of memory* (pp. 21-90). Cambridge: Cambridge University Press.
- Brewer, W. F. (1996). What is recollective memory? In D. C. Rubin (Ed.), *Remembering our past: studies in autobiographical memory* (pp. 19-66). Cambridge: Cambridge University Press.
- Cabeza, R., Grady, C., Nyberg, L., & McIntosh, A. (1997). Age-related differences in neural activity during memory encoding and retrieval: a positron emission tomography study. *Journal of Neuroscience*, *17*(1), 391-400.
- Cabeza, R., & St. Jacques, P. (2007). Functional neuroimaging of autobiographical memory. *Trends in Cognitive Sciences*, *11*(5), 219-227.
- Carlesimo, G. A., & Oscar-Berman, M. (1992). Memory deficits in Alzheimer's patients: a comprehensive review. *Neuropsychology Review*, *3*(2), 119-169.
- Cohen, G., Conway, M. A., & Maylor, E. A. (1994). Flashbulb memories in older adults. *Psychology and Aging*, *9*(3), 454-463.
- Conway, M. A. (1992). A structural model of autobiographical memory. In M. A. Conway, D. C. Rubin, H. Spinnler, & W. A. Wagenaar (Eds.), *Theoretical perspectives on autobiographical memory* (pp. 167-194). Dordrecht: Kluwer Academic Publishers.
- Conway, M. A. (1995). Autobiographical knowledge and autobiographical memories. In D. C. Rubin (Ed.), *Remembering our past: studies in autobiographical memory* (pp. 67-93). Cambridge: Cambridge University Press.
- Conway, M. A. (2001). Sensory-perceptual episodic memory and its context: autobiographical memory. *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences*, *356*(1413), 1375-1384.

- Conway, M. A. (2005). Memory and the self. *Journal of Memory and Language*, 53(4), 594-628.
- Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 382-402). New York: Academic Press.
- Conway, M. A. (2009). Episodic memories. *Neuropsychologia*, 47(11), 2305-2313.
- Conway, M. A., & Bekerian, D. A. (1987). Organization in autobiographical memory. *Memory and Cognition*, 15(2), 119-132.
- Fjell, A. M., & Walhovd, K. B. (2010). Structural brain changes in aging: courses, causes and cognitive consequences. *Reviews in the Neurosciences*, 21(3), 187-221.
- Folkard, S., & Monk, T. H. (1978). Time of day effects in immediate and delayed memory. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory* (pp. 142-168). London: Academic Press.
- Folkard, S., & Monk, T. H. (1979). Time of day and processing strategy in free recall. *Quarterly Journal of Experimental Psychology*, 31(3), 461-475.
- Gais, S., Lucas, B., & Born, J. (2006). Sleep after learning aids memory recall. *Learning and Memory*, 13(3), 259-262.
- Halmai, Z., Dömötör, E., Balogh, G., Sárosi, A., Faludi, G., & Székely, A. (2008). Validation of a new mood questionnaire on healthy sample. *Neuropsychopharmacologia Hungarica*, 10(3), 151-157.
- Hasher, L., Chung, C., May, C. P., & Foong, N. (2002). Age, time of testing, and proactive interference. *Canadian Journal of Experimental Psychology*, 56(3), 200-207.
- Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1990). Aging and qualitative characteristics of memories for perceived and imagined complex events. *Psychology and Aging*, 5(1), 119-126.
- Holmes, E. A., Lang, T. J., Moulds, M. L., & Steele, A. M. (2008). Prospective and positive mental imagery deficits in dysphoria. *Behaviour Research and Therapy*, 46(8), 976-981.
- Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Considering the role of semantic memory in episodic future thinking: evidence from semantic dementia. *Brain*, 135(7), 2178-2191.
- Irish, M., Hornberger, M., Lah, S., Miller, L., Pengas, G., Nestor, P. J., ... Piguet, O. (2011). Profiles of recent autobiographical memory retrieval in semantic dementia, behavioural-variant frontotemporal dementia, and Alzheimer's disease. *Neuropsychologia*, 49(9), 2694-2702.
- Irish, M., & Piguet, O. (2013). The pivotal role of semantic memory in remembering the past and imagining the future. *Frontiers in Behavioral Neuroscience*, 7(27).

- Janssen, S. M. J., Rubin, D. C., & St. Jacques, P. L. (2011). The temporal distribution of autobiographical memory: changes in reliving and vividness over the life span do not explain the reminiscence bump. *Memory and Cognition*, *39*(1), 1-11.
- Jenkins, J. G., & Dallenbach, K. M. (1924). Obliviscence during sleep and waking. *The American Journal of Psychology*, *35*(4), 605-612.
- Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General*, *117*(4), 371-376.
- Kosnes, L., Whelan, R., O'Donovan, A., & McHugh, L. A. (2013). Implicit measurement of positive and negative future thinking as a predictor of depressive symptoms and hopelessness. *Consciousness and Cognition*, *22*(3), 898-912.
- Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: dissociating episodic from semantic retrieval. *Psychology and Aging*, *17*(4), 677-689.
- MacLeod, A. K., & Conway, C. (2007). Well-being and positive future thinking for the self versus others. *Cognition and Emotion*, *21*(5), 1114-1124.
- MacLeod, A. K., & Salaminiou, E. (2001). Reduced positive future-thinking in depression: cognitive and affective factors. *Cognition and Emotion*, *15*(1), 99-107.
- MacLeod, A. K., Tata, P., Kentish, J., & Jacobsen, H. (1997). Retrospective and prospective cognitions in anxiety and depression. *Cognition and Emotion*, *11*(4), 467-479.
- Mather, M., & Knight, M. (2005). Goal-directed memory: the role of cognitive control in older adults' emotional memory. *Psychology and Aging*, *20*(4), 554-570.
- Meulenbroek, O., Rijpkema, M., Kessels, R. P. C., Rikkert, M. G. M. O., & Fernández, G. (2010). Autobiographical memory retrieval in patients with Alzheimer's disease. *NeuroImage*, *53*(1), 331-340.
- Morina, N., Deeprose, C., Pusowski, C., Schmid, M., & Holmes, E. A. (2011). Prospective mental imagery in patients with major depressive disorder or anxiety disorders. *Journal of Anxiety Disorders*, *25*(8), 1032-1037.
- Nader, K. (2003). Memory traces unbound. *Trends in Neurosciences*, *26*(2), 65-72.
- Nader, K., & Einarsson, E. Ö. (2010). Memory reconsolidation: an update. *Annals of the New York Academy of Sciences*, *1191*(1), 27-41.
- O'Connor, R., O'Connor, D., O'Connor, S., Smallwood, J., & Miles, J. (2004). Hopelessness, stress, and perfectionism: the moderating effects of future thinking. *Cognition and Emotion*, *18*(8), 1099-1120.

- Petros, T. V., Beckwith, B. E., & Anderson, M. (1990). Individual differences in the effects of time of day and passage difficulty on prose memory in adults. *British Journal of Psychology*, *81*(1), 63-72.
- Piolino, P., Desgranges, B., Belliard, S., Matuszewski, V., Lalevée, C., Sayette, V. D. L., & Eustache, F. (2003). Autobiographical memory and autothetic consciousness: triple dissociation in neurodegenerative diseases. *Brain*, *126*(10), 2203-2219.
- Philippi, N., Noblet, V., Botzung, A., Després, O., Renard, F., Sfikas, G., ... Blanc, F. (2012). MRI-based volumetry correlates of autobiographical memory in Alzheimer's disease. *PLoS ONE*, *7*(10), e46200.
- Rathbone, C. J., Holmes, E. A., Murphy, S. E., & Ellis, J. A. (2015). Autobiographical memory and well-being in aging: the central role of semantic self-images. *Consciousness and Cognition*, *33*, 422-431.
- Raz, N. (2004). The aging brain: structural changes and their implications for cognitive aging. In R. Dixon, L. Backman, & L-G., Nilsson (Eds.), *New frontiers in cognitive aging* (pp. 115-134). Oxford: Oxford University Press.
- Reuter-Lorenz, P. A., Jonides, J., Smith, E. E., Hartley, A., Miller, A., Marshuetz, C., & Koeppel, R. A. (2000). Age differences in the frontal lateralization of verbal and spatial working memory revealed by PET. *Journal of Cognitive Neuroscience*, *12*(1), 174-187.
- Roediger, H. L., & Marsh, E. J. (2003). Episodic and autobiographical memory. In A. F. Healy & R. W. Proctor (Eds.), *Handbook of psychology, Vol. 4: experimental psychology* (pp. 475-497). New York: John Wiley & Sons.
- Rubin, D. C. (1996). Introduction. In D. C. Rubin (Ed.), *Remembering our past: studies in autobiographical memory* (pp. 3-15). Cambridge: Cambridge University Press.
- Rubin, D. C., & Schulkind, M. D. (1997). The distribution of autobiographical memories across the lifespan. *Memory and Cognition*, *25*(6), 859-866.
- Sagar, H. J., Cohen, N. J., Sullivan, E. V., Corkin, S., & Growdon, J. H. (1988). Remote memory function in Alzheimer's disease and Parkinson's disease. *Brain*, *111*(1), 185-206.
- Sara, S. J. (2000). Retrieval and reconsolidation: toward a neurobiology of remembering. *Learning and Memory*, *7*(2), 73-84.
- Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: remembering the past and imagining the future. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*(1481), 773-786.

- Schacter, D. L., Addis, D. R., & Buckner, R. L. (2007). Remembering the past to imagine the future: the prospective brain. *Nature Reviews Neuroscience*, 8(9), 657-661.
- Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of memory: remembering, imagining, and the brain. *Neuron*, 76(4), 677-694.
- Schacter, D. L., Norman, K. A., & Koutstaal, W. (1988). The cognitive neuroscience of constructive memory. *Annual Review of Psychology*, 49, 289-318.
- Schank, R. C. (1982). *Dynamic memory*. Cambridge: Cambridge University Press.
- Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans goals and understanding*. Hillsdale: Lawrence Erlbaum Associate.
- Souchay, C., & Moulin, C. J. A. (2008). Memory dysfunction. In G. Cohen & M. A. Conway (Eds.), *Memory in the real world* (pp. 357-380). Hove: Psychology Press.
- Stöber, J. (2000). Prospective cognitions in anxiety and depression: replication and methodological extension. *Cognition and Emotion*, 14(5), 725-729.
- Tulving, E. (1983). *Elements of episodic memory*. Oxford: Clarendon Press.
- Tulving, E. (1985). Memory and consciousness. *Canadian Psychology*, 26(1), 1-12.
- Tulving, E., & Markowitsch, H. J. (1998). Episodic and declarative memory: role of the hippocampus. *Hippocampus*, 8(3), 198-204.
- Williams, J. M. G., & Broadbent, K. (1986). Autobiographical memory in suicide attempters. *Journal of Abnormal Psychology*, 95(2), 144-149.
- Williams, J. M. G., Ellis, N. C., Tyers, C., Healy, H., Rose, G., & MacLeod, A. K. (1996). The specificity of autobiographical memory and imageability of the future. *Memory and Cognition*, 24(1), 116-125.
- Williams, J. M. G., & Scott, J. (1988). Autobiographical memory in depression. *Psychological Medicine*, 18(3), 689-695.
- Williams, J. M. G., Teasdale, J. D., Segal, Z. V., & Soulsby, J. (2000). Mindfulness-based cognitive therapy reduces overgeneral autobiographical memory in formerly depressed patients. *Journal of Abnormal Psychology*, 109(1), 150-155.
- Wixted, J. T. (2004). The psychology and neuroscience of forgetting. *Annual Review of Psychology*, 55(1), 235-269
- Wixted, J. T. (2005). A theory about why we forget what we once knew. *Current Directions in Psychological Science*, 14(1), 6-9.