Research on autobiographical memory

Fruzsina Elekes
Judit Kárpáti
Ildikó Király
Anikó Kónya
Márton Nagy
Anett Ragó
Eszter Somos
Ágnes Szőllősi
Brigitta Tóth

Research on autobiographical memory

by Fruzsina Elekes, Judit Kárpáti, Ildikó Király, Anikó Kónya, Márton Nagy, Anett Ragó, Eszter Somos, Ágnes Szőllősi, and Brigitta Tóth
programmer: Roland Boha

Research on autobiographical memory

The aim of this project was to complete mainstream laboratory research on memory function with real world approach, focusing on cognitive processes that underlie everyday personal memories.

TÁMOP 4.1.2.A/1-11/1-2011-0018

Table of Contents

1. Category Learning

Created by Eszter Somos, Anett Ragó
Contact: rago.anett@ppk.elte.hu
Last modification: 2013.06.17.
Experimental software: PsychoPy
Estimated running time: 30-35 min
Package name: I_categorization.zip [http://pszichologia.elte.hu/eltetamop412A1/ronam/I_categorization.zip]

Reference for the original experiment

The original supervised category learning procedure was developed by Posner and Keele (1968)[1]. The main characteristics of this method are:

i. separate phases for learning and for testing of knowledge

ii. participants can learn the categorization rule by getting feedback immediately after their choice

The procedure is mostly used for teaching new categories. The procedure is good for testing implicit or explicit rule learning. While reporting the results authors usually present the learning curve of the learning blocks (change of reaction time and/or hit and error rates), and the recognition rates of the category exemplars shown in the test phase. The test phase contains new category members with different familiarity rates.

Medin, Wattenmaker, and Hampson (1987)[2] introduces the use of family resemblance structure as a good way of measuring the familiarity of category members. Based on the number of matching features with prototype, each member gets a similarity rate. By varying the meaningfulness of the correlating structure of presented features, they created Gestalt like figures. However, they allowed participants to learn categories passively.

Recently Ashby and colleagues use the paradigm we also apply in our experiment (Ashby, Boynton, and Lee, 1994[3]; Ashby and Maddox, 2011[4]; Ell, Ashby, and Hutchinson, 2012[5]), with their more simple experimental material. Their focus is mostly the background mechanisms behind category learning processes.

The aim of development of the category learning experiment presented here was to test the nature of supervised category learning mechanism with more naturalistic stimuli (Rago, Somos, and Konya, 2011[6]). By inventing Gestalt like figures which organized by a family resemblance structure, we would like to imitate real category learning situations.

---

[1]Posner, M. I., and Keele, S. W. (1968). On the genesis of abstract ideas. J Exp Psychol, 77(3), 353-363.
[2]Medin, D. L., Wattenmaker, W. D., and Hampson, S. E. (1987). Family resemblance, conceptual cohesiveness, and category construction. Cogn Psychol, 19(2), 242-279.
[3]Ashby, F. G., Boynton, G., and Lee, W. W. (1994). Categorization response time with multidimensional stimuli. Percept Psychophys, 55(1), 11-27.
[4]Ashby, F. G., and Maddox, W. T. (2011). Human category learning 2.0. Ann N Y Acad Sci, 1224, 147-161. doi: 10.1111/j.1749-6632.2010.05874.x
[5]Ell, S. W., Ashby, F. G., and Hutchinson, S. (2012). Unsupervised category learning with integral-dimension stimuli. Q J Exp Psychol (Hove), 65(8), 1537-1562. doi: 10.1080/17470218.2012.658821
[6]Rago, A., Somos, E., and Konya, A. (2011). The role of goal directed scripts in creating new concepts. 5th International Conference on Memory (ICOM-5), York, UK., 5.

Warning

Run the experiment prior to reading the detailed description for valid results!

Theoretical background

Categorization is a generalization process when we learn to focus on important, so called diagnostic features to be able to identify the members of the category. Even if we know some background causal characteristic which makes the members of the category, we need some perceptual information to be able to recognize them. During category learning we gradually learn the differentiation rule.

The most important theoretical question is the nature of this differentiation rule that is the definition of a category. Breaking the classical viewpoint off, in the 70's Eleanor Rosch created a new and psychologically very relevant concept: prototype (Rosch, 1977)[7]. According to her theory category members are organized according to a family resemblance structure where the best exemplar is the most typical since in total it resembles more to the others, and there are better or worse exemplars according to the degree of their similarity to the prototype. Based on the prototype theory we are able to create a similarity space, where the category members center round the best exemplar. Normally the prototype does not necessarily exist; we can create the mental representation of it by being exposed to different members of the category. In this model there are no singly necessarily and jointly sufficient features that all the members need to possess just typical and atypical characteristics. Later experiments (Mervis and Rosch, 1981[8]; Rosch, 1999[9]) verified the relevance of prototype: recall and recognition rates are better for more typical members of the category, while reaction time and errors are reduced during category decisions. However, that statement according to which the prototypes are uniformly shared in a culture seems not to be valid, and there are other limits of prototype theory (cf. (Barsalou, 1982[10], 1983[11]); Barsalou (1985)[12].

In spite of the success of prototype theory another similarity based approach appeared during the 80's. Exemplar theory assumes that during category learning we don't create a general representation but we store all specific exemplars we have met. During categorization we match the similarity of the presented exemplar to all the stored ones, and by the similarity ratings we decide which category it goes to. This model is relevant as it successfully handles the influence of the context to categorization, the individual variability and the influence of linguistic labels or naïve theories (Proffitt, Coley, and Medin, 2000)[13]. Defining the exact similarity matching procedure is not easy though, that's why many forms of exemplar theories are exist (Medin, 1989[14]; Medin, Altom, and Murphy, 1984[15]; Nosofsky, 1989[16]; Palmeri, 1997[17]).

---

[7]Rosch, E. (1977). Human categorization. Studies in cross-cultural psychology, 1, 1-49.

[8]Mervis, C. B., and Rosch, E. (1981). Categorization of natural objects. Annu Rev Psychol, 32(1), 89-115.

[9]Rosch, E. (1999). Principles of categorization. Concepts: core readings, 189-206.

[10]Barsalou, L. W. (1982). Context-independent and context-dependent information in concepts. Mem Cognit, 10(1), 82-93.

[11]Barsalou, L. W. (1983). Ad hoc categories. Mem Cognit, 11(3), 211-227.

[12]Barsalou, L. W. (1985). Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories. J Exp Psychol Learn Mem Cogn, 11(4), 629-654.

[13]Proffitt, J. B., Coley, J. D., and Medin, D. L. (2000). Expertise and category-based induction. J Exp Psychol Learn Mem Cogn, 26(4), 811-828.

[14]Medin, D. L. (1989). Concepts and conceptual structure. Am Psychol, 44(12), 1469-1481.

[15]Medin, D. L., Altom, M. W., and Murphy, T. D. (1984). Given versus induced category representations: use of prototype and exemplar information in classification. J Exp Psychol Learn Mem Cogn, 10(3), 333-352.

The two competing similarity models are important as they have predictions for category learning processes. In a category learning task prototype theory would imply learning of the general categorization rule, while exemplar theory would hypothesize better recognition of the trained exemplars.

Nowadays there is another, neuropsychological approach of category learning. According to multiple system models (cf. Ashby (1992)[18]; Ashby, Alfonso-Reese, Turken, and Waldron (1998)[19]; Ashby and Maddox (2005)[20]; Erickson and Kruschke (1998)[21]; Love, Medin, and Gureckis (2004)[22]; Reber, Gitelman, Parrish, and Mesulam (2003)[23]) category learning process is usually implicit. However, when the categorization rule is easily describable verbally, the explicit memory system will take over directing learning. The two systems are antagonistic.

The shortcomings of these models is that they can make predictions only in case of well know paradigms. Actually, the used learning paradigms and stimuli define the learning systems are involved and not vice versa.

In our original experiment (Rago et al., 2011) we wanted to test the possible contribution of different learning systems in case of a more natural stimulus which is more similar to the objects we easily categorize based on encountering different exemplars.

In a paradigm, where exemplars are easily identifiable and memorable we have to use both (exemplar)-specific and general (rule) information for a successful categorization. Moreover, we have test the nature of memory storage of this dual knowledge for a long time according to be useful in different contexts. Since we usually learn verbal labels connected to categories, we also need to know the exact nature of the interaction or involvement of implicit and explicit memory systems.

Here we present a category learning experiment with naturalistic, Gestalt-type stimuli, organized by a family resemblance structure. The stimulus set was created artificially by the help of Spores Creature Creator Software (Electronic Arts Inc.).

We created an information-integration task where participants had to acquire a complex categorization rule without being able to verbalize it. Four diagnostic features defined category membership. In order to tell the category membership of exemplars, participants need to calculate how many diagnostic feature of a category they possess altogether. An exemplar possesses more diagnostic features of a category, will be more similar to the prototype of that category. The prototype possesses all 4 diagnostic features of the category, the close-to-prototype members (CP) share 3 diagnostic features with the prototype, and the far-to-prototype (FP) exemplars share only 2. In order to avoid ambiguity there were neutral diagnostic features which themselves couldn't tell

[16]Nosofsky, R. M. (1989). Further tests of an exemplar-similarity approach to relating identification and categorization. Percept Psychophys, 45(4), 279-290.

[17]Palmeri, T. J. (1997). Exemplar similarity and the development of automaticity. J Exp Psychol Learn Mem Cogn, 23(2), 324-354.

[18]Ashby, F. G. (1992). Multidimensional models of categorization.

[19]Ashby, F. G., Alfonso-Reese, L. A., Turken, A. U., and Waldron, E. M. (1998). A neuropsychological theory of multiple systems in category learning. Psychol Rev, 105(3), 442-481.

[20]Ashby, F. G., and Maddox, W. T. (2005). Human category learning. Annu Rev Psychol, 56, 149-178. doi: 10.1146/annurev.psych.56.091103.070217

[21]Erickson, M. A., and Kruschke, J. K. (1998). Rules and exemplars in category learning. J Exp Psychol Gen, 127(2), 107-140.

[22]Love, B. C., Medin, D. L., and Gureckis, T. M. (2004). SUSTAIN: a network model of category learning. Psychol Rev, 111(2), 309-332. doi: 10.1037/0033-295X.111.2.309

[23]Reber, P. J., Gitelman, D. R., Parrish, T. B., and Mesulam, M. M. (2003). Dissociating explicit and implicit category knowledge with fMRI. J Cogn Neurosci, 15(4), 574-583. doi: 10.1162/089892903321662958

the category membership. By adding individual non-diagnostic features to each of the creatures, we allowed the possibility of storing specific exemplars (For the stimulus structure see Figure1).

Figure 1. Exemplar types of the experiment. In the top row there are the two prototypes for the two categories (AAAA and BBBB). In the middle row there are the close-to-prototype (CP) exemplars which share three diagnostic features with the prototype of their category (AACA, AABA, ABAC and BBCB, BBAB, BABC). Below row shows the far-from-prototype (FP) exemplars (ABCA, ACBA, BAAC and BACB, BCAB, ABBC).

In this supervised teaching paradigm participants learn category memberships by seeing only FP exemplars. In the test phase prototypes, CP exemplars, learned FPs, and new FP exemplars are exposed.

By the application of this setting we are able to test the nature of prototype generalization: rule learning and exemplar effect. If participants learn the categorization rule by seeing FPs, they will categorize the prototypes they haven't seen before better than the FPs they saw during the learning phase (3 times). If the rule is generated by the family resemblance structure, than the hitting rates will follow this graded structure. However, if participants focus on individual exemplars and store them during learning, then, hitting rates will be bigger for FP they saw during learning. We expect that reaction time results will follow the hitting rates (decline for better hitting rates and increase for worse hitting rates).

Procedure

1. Download the experiment file and the stimuli directory and unzip the stimuli directory.
2. At the beginning of the experiment an information window pops up.
    a. Here you can type in the name and the date of birth of the participant. This information will be used for naming the logfile. (see Figure 2)
    b. You also have to fill in the training and the test stimuli directory boxes. You should type in the path of these directories on your computer following the given format (e.g.: C:\Users\Documents\Experiments\Categorization\Training\). In case of the training stimuli directory box you should give the path to the Training directory; in case of the test stimuli directory box you should give the path to the Test directory.

You should also type in a path of a directory in the Logfile directory field. The logfile containing your results will be placed there.

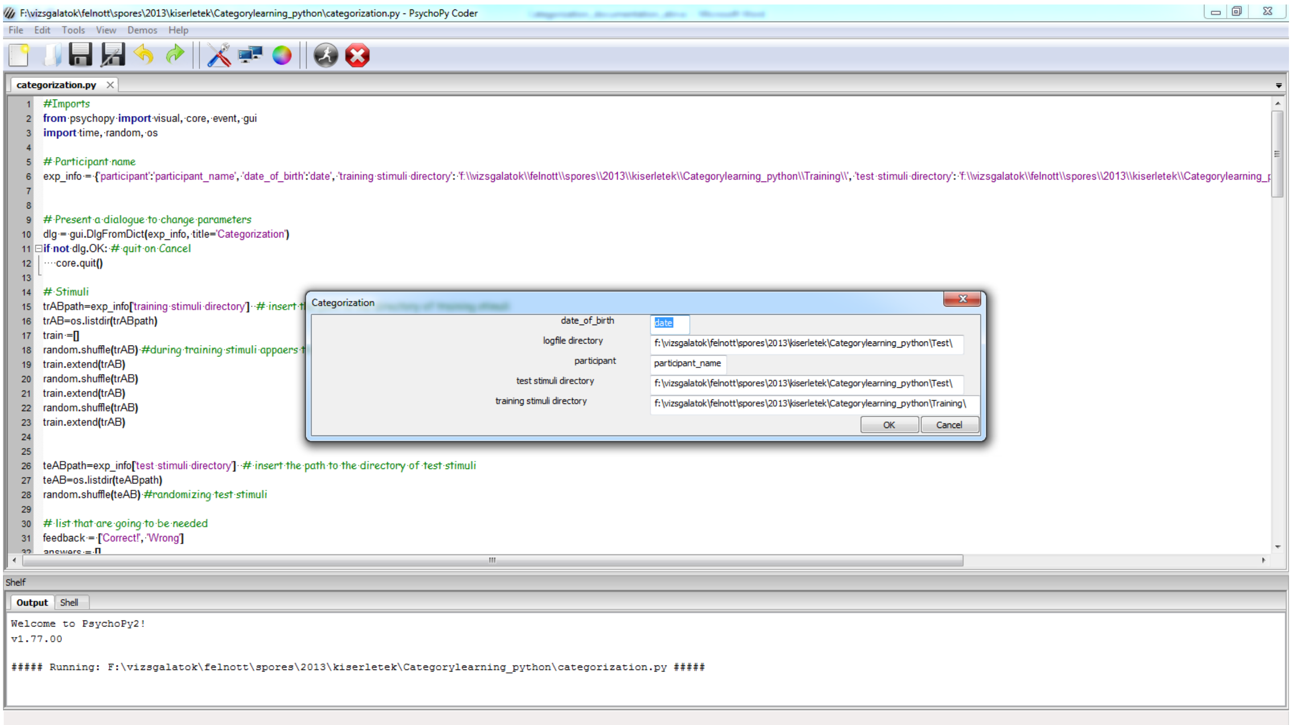


Figure 2. The information window with specifications.

3. Here the experiment starts. An instruction window comes where participants can see the description of the task (see Figure 3). During the training session the stimuli is presented one by one. Participants have to decide for each stimulus if it is a member of category A or B by typing the given computer keys. After their decision a corrective feedback is given. There are 3 training circles each consisting of 72 FP exemplars.

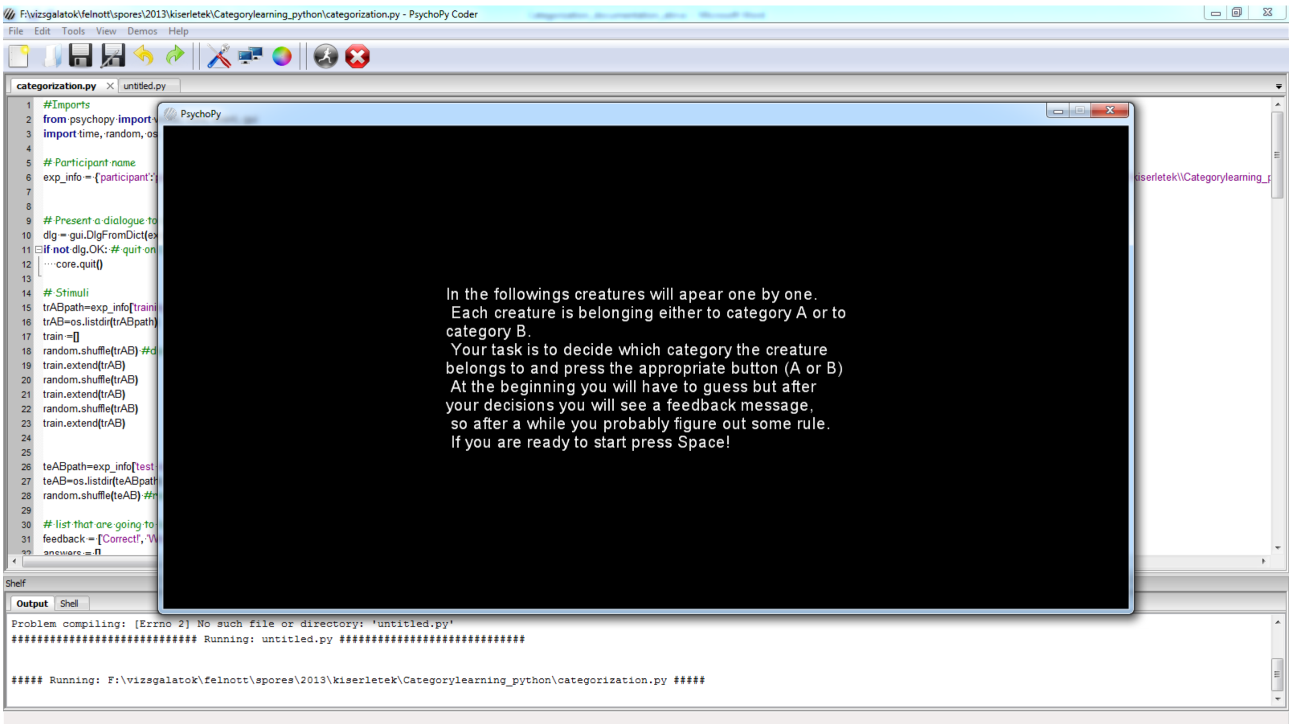


Figure 3. The instruction of the experiment.

4. When the training phase ends, a new instruction pops up. Participants are informed that they have finished training and now, in the test session they are able to show what they learned. The procedure of the test session is similar to the training sessions' but now there is no feedback. The test stimuli consist of prototypes, CPs, and FPs as well. In total there are 48 exemplars in the test phase.

Expected Results

After finishing the experiment you will find a logfile in your logfile directory named by the participant's name and date of birth. In this 'txt' file you can find your average hit rates and reaction times for the answers during the test session for the three kinds of stimuli (prototypes, CPs, FPs). You can also find the average results from our previous experiment to which you can compare the performance of the participants. Below these there are the answers and reaction times for all of the stimuli in the order of appearance. 1 stands for a correct answer, and 0 stands for a miss. The reaction times are given in seconds.

A typical result shows that the hit rates follow the typicality of the exemplars, while the reaction times represent a reversed pattern (see Figure 4). These results are in line with the prototype theory since in spite of training with far from prototype exemplars the final performance is better if an exemplar is nearer to the prototype.

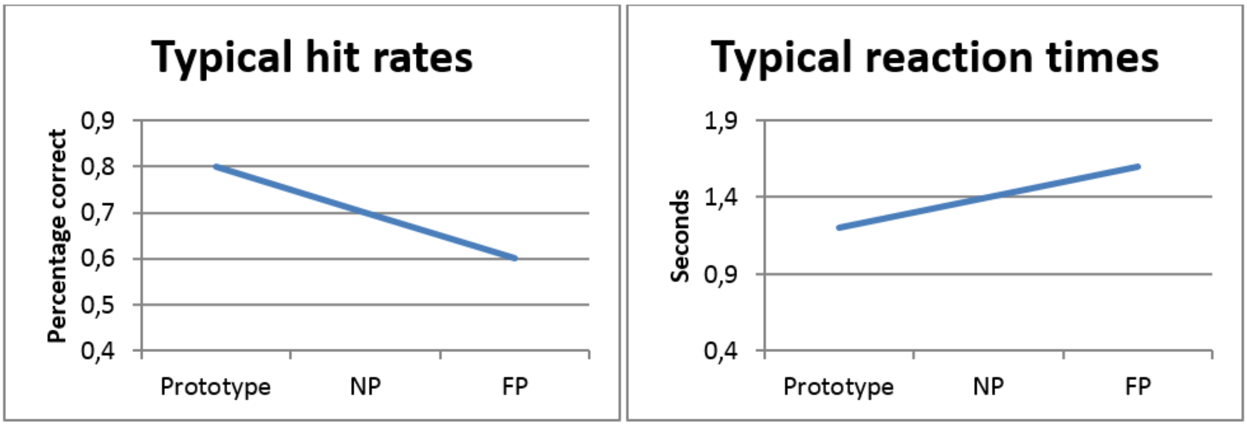


Figure 4. Typical hit rates and the reaction time curve.

Recommended readings

- Barsalou, L. W. (1987). The instability of graded structure: Implications for the nature of concepts.
- Mervis, C. B., and Rosch, E. (1981). Categorization of natural objects. Annual review of psychology, 32(1), 89-115.
- Rips, L. J. (1989). Similarity, typicality, and categorization. Similarity and analogical reasoning, 21-59.
- Rosch, E., and Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. Cognitive psychology, 7(4), 573-605.

2. Memory Experiments

2.1. Remember-Know Paradigm

Created by Márton Nagy, Brigitta Tóth
Last modification: 2013.07.11.
Experimental software: PsychoPy
Estimated running time: 15-20 minutes
Package name: II1_memoryexperiments_rkp.zip [http://pszichologia.elte.hu/eltetamop412A1/ronam/II1_memoryexperiments_rkp.zip]
Reference for the original experiment: Dewhurst, S. A., Holmes, S. J., Brandt, K. R., and Dean, G. M. (2006). Measuring the speed of conscious components of recognition memory: Remembering is faster than knowing. Consciousness and Cognition, 15, 147-162.

Theoretical background

Imagine how you might respond on a multiple-choice test in school. Sometimes, you just know the answer; other times, you actually remember having learned the material, such as when it appeared on the lecture. Remembering and knowing refers todistinct states during the retrieval of facts and experiences from our past. Multiple-choice test in school is actually can be seen equivalent with the recognition test of a memory experiment. Rememberingis the conscious recollection of contextual details, such as "when" and "how" the information was learned which utilize episodic memory (e.g. remember having learned the material, such as when it appeared on lecture). To know is a feeling of familiarity of an item without recollection (e.g. you just know the answer in the same way as you know that Barack Obama is President of the United States, even though you don't remember anything about what you experienced at the time that the information was presented) which utilize semantic memory. Remember - know distinction originally (Tulving, 1985)[1] intended to separate episodic (person's awareness that an event is a part of his own past existence) from semantic memory (person's symbolic knowledge of the world). The dominant view today is that recollection-based decisions underlie remember responses, whereas familiarity-based decisions underlie know responses (Gardiner, Ramponi, and Richardson-Klavehn, 2002)[2]. Recognition by retrieval involves remembering an event as an event, including the context (personal and spatiotemporal)of occurrence of the event; by contrast, recognition by familiarity involves an intuition that some event occurred in the past. Errors in recollection assumed to arise from incorrect source-monitoring of retrieved event memory details. Errors in familiarity assumed to arise from incorrect encoding and rehearsal of the event.

[1]Tulving E. (1985). Memory and consciousness. Canadian Psychology/Psychologie Canadienne, 26(1), pp. 1-12. doi:10.1037/h0080017. Retrieved from: psycnet.apa.org
[2]Gardiner, J. M., Ramponi, C., and Richardson-Klavehn, A. (2002). Recognition memory and decision processes: a meta-analysis of remember, know, and guess responses. Memory (Hove, England), 10(2), 83–98. doi:10.1080/09658210143000281

Procedure

Stimuli

The experiment uses a pool of 60 English nouns. The nouns are chosen from the three most frequent answers of 48 categories of the renewed Battig and Montague (1969)[3] norms (Overschelde, Rawson and Dunlosky, 2004)[4]. The nouns are neutral, 1-3 syllable words.

Running the experiment

To run the experiment you have to open the remember-know test file (RememberKnowParadigm.py) which is located in the II1_memoryexperiments_rkp.zip archive. After you hit the run button ('Ctrl + R' or the green round button with a running man's silhouette) a dialogue box appears. There will be 4 different fields that you have to fill in. In the field called **Participant** you have to give the participant's name or code. The name or code you type in here will be used to save the output file when the test finishes (pay attention to remember it). The next two fields stand for the **Gender** (female or male) and the **Age** of the participant. The last field controls the experiment screen (**Monitor**). If you want to run the experiment on your primary screen you have to use 0 (if you have just one screen that is your primary screen). If you have a dual-screen setup and you want to present the experiment on your secondary screen you have to use 1.

After you fill in all the fields you have to hit OK on the dialogue box and the experiment starts. The first what you see is the **learning instruction screen**. After you've read what the task will be you have to hit any key on the keyboard to start the **learning phase** (these instructions are presented also on the screen during the experiment). One trial of the learning phase consists of a fixation square appearing in the middle of the screen for 0.5 second. After the fixation an English noun appears for 2.0 seconds in the middle which has to be remembered. There are 30 trials (30 nouns chosen randomly from the 60 noun wordpool).

After the learning phase there will be a **delay screen**. The delay screen pauses the experiment and gives you the option to introduce some time between the learning and test phase. The widely used delay duration in the literature is 5-10 minutes. On the delay screen the instruction tells the participant that for resuming the experiment he just have to press a button. Be careful to tell the participants that you will tell them when they can resume the experiment. During the delay you can give secondary tasks to the participants to reduce the possibility that they use mental resources to encode the stimuli.

After the delay the **test instruction screen** will appear. The instructions for remember, know and new answers are from Geraci, McCabe and Guillory (2009)[5]. After reading the instruction the **test phase** starts by pressing any button. One trial of the test phase consists of a fixation square in the middle of the screen appearing for 0.5 second. After the fixation an English noun will be presented. The noun will be on the screen until one of the two active keys is pressed (D for remember answer, K for know answer and SPACE for new answer). This method is called the one-step remember-know paradigm (Dewhurst et al., 2006)[6]. During the test phase there

[3]Battig, W. F., and Montague, W. E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut norms. Journal of Experimental Psychology, 80, 1–46.

[4]Overschelde, J. P. V., Rawson, K. A., and Dunlosky, J. (2004).Catregory norms: An updated and expanded version of the Battig and Montague (1969) norms. Journal of Memory and Language, 50, 289-335.

[5]Geraci, L., McCabe, D. P. and Guillory, J. J. (2009). On interpreting the relationship between remember-know judgements and confidence: the role of instructions. Consciousness and Cognition. 18, 701-709.

[6]Dewhurst, S. A., Holmes, S. J., Brandt, K. R., and Dean, G. M. (2006).Measuring the speed of conscious components of recognition memory: Remembering is faster than knowing.Consciousness and Cognition, 15, 147-162.

are 30 old nouns (from the learning phase) and 30 new nouns (the rest from the 60 noun wordpool) presented in random order.

After you finish the experiment the program will quit and save a tab-delimited .txt file to the folder of the .py script file with the name **Output_'Participant'.txt**. In the output file you will have a header containing 4 lines. The header contains information you typed in at the start of the experiment (Participant, Gender, Age). After these information there will be 4 columns with data from the experiment. The first column will show the participant's answer. It can have 3 different values (1, 2 or 3). The meaning for the numbers are also in brackets in the output file: 1 = remember, 2 = know and 3 = new answer. The second column will contain the reaction time data in seconds. The third contains if the presented word was old (presented during the learning phase) or new (presented only during the test phase). The third column can have values 0 or 1: 0 = new, 1 = old word.

Expected Results

Using this particular experiment and calculating the hit rate and false alarm rate for the *remember* and *know* responses it is generally true that there are more *remember* hits than *know* hits and there are less *remember* false alarms than *know* false alarms.

2.2. Directed Forgetting Paradigm

Created by Márton Nagy, Brigitta Tóth
Last modification: 2013.07.11.
Experimental software: PsychoPy
Estimated running time: 15-20 minutes
Package name: II2_memoryexperiments_dfp.zip [http://pszichologia.elte.hu/eltetamop412A1/ronam/II2_memoryexperiments_dfp.zip]

Theoretical background

There are times when information should be forgotten, typically when such information is irrelevant to a particular task or has little future value (e.g. while a student preparing for an upcoming exam there are a lot of information has been read from a textbook which has no significance for a certain topic). Forgetting is crucial for the efficient use of memory. It allows for updating goal relevant information, and thereby is effective in reducing interference between the irrelevant and relevant information. This interference reduction (refers to directed forgetting also known as intentional forgetting) can occur intentionally by using explicit instructions. Directed forgetting is an experimental procedure in which individuals are told that they can forget some of the information being presented to them. This can be induced in two ways:by the list method procedure (Anderson, Bjork, and Bjork, 1994)[7], and by the item method of directed forgetting (MacLeod, 1999)[8]. In the item method paradigm participants are presented with a series of items like as words and each encoded items (e.g. words) are followed by an instruction either to "remember" or to "forget". The participants were not informed that that they will be tested on the to-be-forgotten items as well. These instructions result reduced recognition memory

[7]Anderson, M. C., Bjork, R. a, and Bjork, E. L. (1994). Remembering can cause forgetting: retrieval dynamics in long-term memory. Journal of experimental psychology. Learning, memory, and cognition, 20(5), 1063–87. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7931095

[8]MacLeod, C. M. (1999). The item and list methods of directed forgetting: test differences and the role of demand characteristics. Psychonomic bulletin and review, 6(1), 123–9. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12199306

for the to-be-forgotten information compared to the recognition of be-remembered information, which effect is called directed forgetting. The directed forgetting effect has been demonstrated on recognition and recall tests thereby it is assumed that the item method reflectsselection during episodic encoding. Different memory mechanismswereproposed to underlie the forgetting effect in list and item methods. List method assumed to cause inhibition of the to-be-forgotten information. The item method of directed forgetting effect could be explained by to mechanisms: the more elaborate processing of the relevant (to be remembered information) items by rehearsal and the attentional inhibition of the irrelevant (to be forgotten information) items.

Procedure

Stimuli

The experiment uses a pool of 60 English nouns. The nouns are chosen from the third most frequent answers of 48 categories of the renewed Battig and Montague (1969)[9] norms (Overschelde, Rawson, Dunlosky, 2004)[10]. The nouns are neutral, 1-3 syllable words.

Running the experiment

To run the experiment you have to open the directed forgetting paradigm file (DirectedForgettingParadigm.py) which is located in the DirectedForgettingParadigm.zip archive. After you hit the run button ('Ctrl + R' or the green round button with a running man's silhouette) a dialogue box appears. There will be 4 different fields that you have to fill in. In the field called **Participant** you have to give the participant's name or code. The name or code you type in here will be used to save the output file when the test finishes (pay attention to remember it). The next two fields stand for the **Gender** (female or male) and the **Age** of the participant. The last field controls the experiment screen (**Monitor**). If you want to run the experiment on your primary screen you have to use 0 (if you have just one screen that is your primary screen). If you have a dual-screen setup and you want to present the experiment on your secondary screen you have to use 1.

After you fill in all the fields you have to hit OK on the dialogue box and the experiment starts. The first what you see is the **learning instruction screen**. After you've read what the task will be you have to hit any key on the keyboard to start the **learning phase** (all the instructions are presented also on the screen during the experiment). One trial of the learning phase consists of a fixation square appearing in the middle of the screen for 2 seconds. After the fixation an English noun appears for 1 second in the middle. Next there is a blank screen for 1 second which is followed by the instruction (remember or forget) for 1 second. There are 40 trials (20 nouns to be remembered and 20 nouns to be forgotten). All the words are chosen randomly from the 60 noun wordpool.

After the learning phase there will be a **delay screen**. The delay screen pauses the experiment and gives you the option to introduce some time between the learning and test phase. On the **delay screen** the instruction tells the participant that for resuming the experiment he just have to press a button. Be careful to tell the participants before the start that you will tell them when they can resume the experiment. During the delay you can give secondary tasks to the participants (e.g., to reduce the possibility that they use mental resources to encode the stimuli.

[9]Battig, W. F., and Montague, W. E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut norms. Journal of Experimental Psychology, 80, 1–46.
[10]Overschelde, J. P. V., Rawson, K. A., and Dunlosky, J. (2004).Catregory norms: An updated and expanded version of the Battig and Montague (1969) norms. Journal of Memory and Language, 50, 289-335.

The delay is followed by the **test instruction screen**. After reading the instruction the **test phase** starts by pressing any button. One trial of the test phase consists of a fixation square in the middle of the screen appearing for 0.5 second. After the fixation an English noun will be presented. The noun will be on the screen until one of the two active keys is pressed (*D* for *old* answer, *K* for *new* answer). This is a simple recognition memory task. During the test phase there are 40 old nouns (20 which had remember instructions and 20 which had forget instructions) and 20 new nouns (the residuals from the 60 noun wordpool) presented in random order.

After you finish the experiment the program will quit and save a tab-delimited .txt file to the folder of the .py script file with the name **Output_'Participant'.txt** ('Participant' is replaced by the name given at the dialogue box). The header contains information you typed in at the start of the experiment (Participant, Gender, Age). After these information there will be 4 columns with data from the experiment. The first column will show the participant's answer. It can have 2 different values (0 or 1). The meaning for the numbers are also in brackets in the output file: 0 = new answer, 2 = old answer. The second column will contain the reaction time data in seconds. The third contains if the presented word was old (presented during the learning phase) or new (presented only during the test phase). The third column can have values 0 or 1: 0 = new, 1 = old word. The fourth column stands for the instruction type during the learning phase. It can have two values (0 or 1): 0 = forget, 1 = remember instruction.

Expected Results

For the to-be-forgotten words there will be a lower recognition performance (hit rate) than for the to-be-remembered words. This is the directed forgetting effect.

Recommended readings

Wenzel, Amy (Ed); Rubin, David C. (Ed) Cognitive methods and their application to clinical research.American Psychological Association, Washington, DC, US, http://www.apa.org.arugula.cc.columbia.edu:2048/books

2.3. Picture-based False Memory

Created by Márton Nagy, Brigitta Tóth
Last modification: 2013.07.11.
Experimental software: Psychopy
Estimated running time: 10-15 minutes
Package name: II3_memoryexperiments_pfm.zip [http://pszichologia.elte.hu/eltetamop412A1/ronam/II3_memoryexperiments_pfm.zip]
Reference for the original experiment: Balázs Hámornik (2007).The picture method of false memory and its relation to executivefunctions. Master thesis at ELTE University, Budapest Department of Psychology.

Theoretical background

Memories can be false/illusory in many ways (e.g., believing someone last saw the sunglass in the hall when they were in the living room, or when an eyewitness mistakenly identify somebody as a robber). False memory refers to phenomenon in which people remember incorrectly events or,believe that the events never happened at all. Memory illusions and distortions assumed to arise from the same processes as do correctly remembered memories thereby studies of them supposed to reveal basic memory mechanisms.

1) Inaccurate perception: Events can be encoded inaccurately (thereby remembered incorrectly) due to the distortion of sensory perception while event occurs. Consider the eyewitness who have seen a murder only briefly, in the dark, from a distance, and while experiencing stress – which reduce her ability to identify the murderer.

2) Inferences: False memories may also arise from inferences made during an event. The witness to a crime is actively trying to figure out what is going on during the event, and uses prior knowledge to make sense of what is happening. Application ofprior knowledge could alter what people remember.

3) Interference: Typically many events can occur after a certain memory was stored thereby events experienced later may interfere with retrieval of the original event(the eyewitness may read newspaper about a crime) and later stored memories may inhibit the access to the representation of the original one.

4) Similarity: False memories can arise when somebody incorrectlyrecognize new items on a recognition test as previously seen one due to their similarity to original events. Consider that an eyewitnessgave a description of the robber to the police and later the police put a suspect into a line-up with other people fitting the same general description. As like in recognition test, eyewitness should pick the previously seen robber out of the line-up, however because of visual similarity someone elsewill be falsely recognized as the actual robber. Experimental studies showed that exposure to similar events (e.g. semantically similar) can create illusory memories (Miller and Gazzaniga, 1998[11] see also Roediger, and McDermott, 1995[12]).

5) Misattributions of familiarity: False memories can also arise when items are familiar but it is source misinterpreted. A well-known demonstration is the false fame effect in which participants instructed to memorize a list of non-famous names and during the following recognition test they have to decide whether each names is famous or not. Since the previously seennon-famous names seemed familiar for the participants, theyjudged the studiednon-famous namesmore famous than the non-famous names which were not presented in the study list (Jacoby et al. 1989).

Procedure

(This experimental method was created by Balázs Hámornik (2007)[13].)

Stimuli

The experiment uses 8 photographs of different scenes (Office, Beach, Tram station, Budapest - Chain Bridge, London - Buckingham Palace, Moon, Garden, Smith) for the learning phase. There are 62 nouns in the test phase (19 learned, 23 critical, 20 new).

[11]Miller, M. B., and Gazzaniga, M. S. (1998). Creating false memories for visual scenes. Neuropsychologia, 36(6), 513–20. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9705061

[12]Roediger, H.L., and McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. Journal of Experimental Psychology: Learning, Memory and Cognition, 24(4), 803–814.

[13]Balázs Hámornik (2007). The picture method of false memory and its relation to executivefunctions. Master thesis at ELTE University, Budapest Department of Psychology.

Running the experiment

To run the experiment you have to open the false memory experiment file (PFM.py) which is located in the PFM.zip archive. You have to make sure that the 8 picture files used in the experiment are in the same folder as the script (PFM.py). After you hit the run button ('Ctrl + R' or the green round button with a running man's silhouette) a dialogue box appears. There will be 4 different fields that you have to fill in. In the field called **Participant** you have to give the participant's name or code. The name or code you type in here will be used to save the output file when the test finishes (pay attention to remember it). The next two fields stand for the **Gender** (female or male) and the **Age** of the participant. The last field controls the experiment screen (**Monitor**). If you want to run the experiment on your primary screen you have to use 0 (if you have just one screen that is your primary screen). If you have a dual-screen setup and you want to present the experiment on your secondary screen you have to use 1.

After you fill in all the fields you have to hit OK on the dialogue box and the experiment starts. The first what you see is the **learning instruction screen**. After you've read what the task will be you have to hit any key on the keyboard to start the **learning phase** (all the instructions are presented also on the screen during the experiment). One trial of the learning phase consists of a fixation square appearing in the middle of the screen for 3 seconds. After the fixation photograph of a scene appears for 10 seconds in the middle which details have to be remembered. There are 8 photos presented in random order.

Following the learning phase there will be a **delay screen**. The delay screen pauses the experiment and gives you the option to introduce some time between the learning and test phase. On the delay screen the instruction tells the participant that for resuming the experiment he just have to press a button. Be careful to tell the participants before the start that you will tell them when they can resume the experiment. During the delay you can give secondary tasks to the participants (e.g., to reduce the possibility that they use mental resources to encode the stimuli).

After the delay the **test instruction screen** will appear. After reading the instruction the **test phase** starts by pressing any button. One trial of the test phase consists of a fixation square in the middle of the screen appearing for 1 second. After the fixation an English noun will be presented. The noun will be on the screen until one of the two active keys is pressed (*D* for *new* answer, *K* for *old* answer). During the test phase there are 62 trials (62 nouns). There are 23 critical item which were not present in any of the photos but they are semantically related to one of the scenes, 19 old items which were present in the scenes and 20 new item which were not present on any of the photos and are not related to any of the scenes.

After you finish the experiment the program will quit and save a tab-delimited .txt file to the folder of the .py script file with the name **Output_'Participant'.txt**. The header contains information you typed in at the start of the experiment (Participant, Gender, Age). After these information there will be 3 columns with data from the experiment. The first column will show the participant's answer. It can have 2 different values (0 or 1). The meaning for the numbers are also in brackets in the output file: 0 = new answer, 1 = old answer. The second column will contain the reaction time data in seconds. The third contains the presented word's type (critical, old, new). The third column can have values 1-3: 0 = new, 1 = old, 3 = critical word.

Expected Results

The false alarm rate will be higher for the critical words than for new words. This effect is the false recognition of visually not presented but semantically relevant details.

3. Computerized assessment of spatio-temporal memory

Created by Kárpáti Judit, Kónya Anikó and Boha Roland
Contact: karpati.judit@t-online.hu
Last modification: 2013.09.10.
Experimental software: Java
Estimated running time: 20-25 minutes
Package name: III_stm.zip [http://pszichologia.elte.hu/eltetamop412A1/ronam/III_stm.zip]
Reference for the original experiment: Postma et al. (2006). Spatial and temporal order memory in Korsakoff patients. Journal of the International Neuropsychological Society, 12, 327–336.

Theoretical background

Working memory binds together objects and contextual information from multiple sources by forming coherent episodes of the world around us. But a challenging question is to what extent are these binding processes automatic and under what conditions rely on consciousness?

Köhler, Moscovitch and Melo (2001)[1] found that the binding of object identity and object location (what and where) is automatic however several studies have shown that a more complex binding which also involves temporal order of objects is an effortful process (e.g. Van Asselen et al, 2006[2]; Delogu et al, 2012[3]). The exact mechanism behind this cognitive effort is not entirely clear. In previous studies, tasks which assess spatio-temporal memory include not only spatial and temporal information but also object identity: participant has to remember the spatio-temporal organization of distinct objects. In these tasks, the temporal information is two-folded: participant has to remember the spatial sequential organization of items and also the verbal order of objects.

The method we present here is based on Postma and his colleagues' (2006)[4] spatio-temporal procedure. We modified their method and added some new tasks by allowing us to separate spatio-temporal binding with and without object identity – and consequently also to separate spatial and verbal temporal information within the tasks. Our results suggest that spatio-temporal binding without object identity (where and when) might be automatic in itself, but the multiple binding of object identity and spatio-temporal contextual information (what, where and the spatial and verbal when) is an effortful process even for adults (Kárpáti, Király and Kónya, 2013). Therefore, it suggests that the main reason of cognitive effort behind spatio-temporal binding is not the binding of spatial and temporal information but rather the binding of verbal and spatial temporal information.

The method we present here offers an opportunity to measure spatio-temporal memory components separately and together in all ages from 5 years to elderly adults.

---

[1]Köhler, S., Moscovitch, M., Melo, B. (2001): Episodic memory for object location versus episodic memory for object identity: Do they rely on distinct encoding processes? Memory and Cognition, 29(7), 948-959.
[2]Van Asselen, M. Van der Lubbe, R., Postma, A. (2006): Are space and time automatically integrated in episodic memory? Memory, 14(2), 232-240.
[3]Delogu, F. W., Nijboer, T. C., Postma, A. (2012): Binding "when" and "where" impairs temporal, but not spatial recall in auditory and visual working memory. Frontiers in Psychology: Cognitive Science, 62(3), 1-6.
[4]Postma, A., Asselen, M. Van, Keuper, O., Wester, A. J., Kessels, R. P. C. (2006): Spatial and temporal order memory in Korsakoff patients. Journal of the International Neuropsychological Society, 12(3), 327-336.

Procedure

You can see below the eight different tasks which provide an opportunity of systematic examination of spatio-temporal memory.

Tasks

Task's name (presentation-recall)	**Descriptions**	**Instructions**
1.Corsi-like task (spatio-temporal presentation with homogenous dots - spatio-temporal recall with homogenous dots)	*Presentation:* Black dots appearserially in various locations on the screen. Each item appears for the same predefined time period. *Recall:* The previously presented dots reappear simultaneously in their original positions. Participant has to click on the dots in the order they were presented initially then click on the box labeled 'finished'.	In this test, black dots will appear on the screen. The number of black dots will increase with each trial. **Try to remember the order of the dots. After the presentation you have to click on the dots in the same order as they were presented originally.** You will have some practice trials in the beginning.
2.Purely spatial task (spatial presentation with distinct pictures – spatial recall with distinct pictures)	*Presentation:* Randomly selected pictures appearsimultaneously in various locations on the screen and disappear after the predefined time period. *Recall:* The previously presented pictures reappear on the top of the screen and black dots mark their original positions. Participant has to relocate the objects to their correct positions then click on the box labeled 'finished'.	In this test, objects will appear on the screen. The number of objects will increase with each trial. **Try to remember the location of each of the objects. After the presentation you have to relocate them to their original positions.** In the beginning of the task you will have some practice trials.
3.Purely temporal task 1.	*Presentation:*	In this test, objects will appear on the screen. The number of objects will increase with each trial.

(temporal presentation with distinct pictures – recall by putting distinct objects into a box in the center of the screen)	Randomly selected pictures appearserially in the center of the screen. Each item appears for the same predefined time period. *Recall:* The previously presented pictures reappear on the top of the screen. Participant has to put the objects into a box centered on the screen in the original temporal order then click on the box labeled 'finished'.	**Try to remember the temporal order of the objects. After the presentation you have to put them into a box in the same temporal order as they were presented originally.** You will have some practice trials in the beginning.
4.Purely temporal task 2. (temporal presentation with distinct pictures – recall by arranging distinct objects in a row)	*Presentation:* Randomly selected pictures appearserially in the center of the screen. Each item appears for the same predefined time period. *Recall:* The previously presented pictures reappear on the top of the screen. Participant has to place the objects in the correct temporal order on horizontal dots, The leftmost dot should be assigned to the object that was presented first and the rightmost dot should be assigned to the last shown item then click on the box labeled 'finished'.	In this test, objects will appear on the screen. The number of objects will increase with each trial. **Try to remember the temporal order of the objects. After the presentation you have to arrange them in the same temporal order as they were presented originally.** You will have some practice trials in the beginning.
5.Combined task with corsi-like recall (spatio-temporal presentation with distinct pictures – spatio-temporal recall with homogenous dots)	*Presentation:* Randomly selected pictures appearserially in various locations on the screen. Each item appears for the same predefined time period.	In this test, objects will appear on the screen. The number of objects will increase with each trial. **Try to remember the order of the objects. After the presentation you have to**

	Recall: In the positions of previously presented objects black dots appear simultaneously. Participant has to click on the dots in the order the objects were presented initially then click on the box labeled 'finished'	**click on black dots in the same order as the objects were presented originally.** You will have some practice trials in the beginning.
6.Combined task with spatial recall (spatio-temporal presentation with distinct pictures - spatial recall with distinct pictures)	*Presentation:* Randomly selected pictures appearserially in various locations on the screen. Each item appears for the same predefined time period. *Recall:* The previously presented pictures reappear on the top of the screen and black dots mark their original positions. Participant has to relocate the objects to their original positions (regardless of the order) then click on the box labeled 'finished'.	In this test, objects will appear on the screen. The number of objects will increase with each trial. **Try to remember the location of each of the objects. After the presentation you have to relocate them to their original positions.** You will have some practice trials in the beginning.
7.Combined task with temporal recall (spatio-temporal presentation with distinct pictures - recall by putting distinct objects into a box in the center of the screen)	*Presentation:* Randomly selected pictures appearserially in various locations on the screen. Each item appears for the same predefined time period. *Recall:* The previously presented pictures reappear on the top of the screen. Participant has to put the objects into a box centered on the screen in the original temporal order then click on the box labeled 'finished'.	In this test, objects will appear on the screen. The number of objects will increase with each trial. **Try to remember the order of the objects. After the presentation you have to put them into a box in the same temporal order as they were presented originally.** You will have some practice trials in the beginning.

8.Fully combined task (spatio-temporal presentation with distinct pictures – spatio-temporal recall with distinct pictures)	*Presentation:* Randomly selected pictures appearserially in various locations on the screen. Each item appears for the same predefined time period. *Recall:* The previously presented pictures reappear on the top of the screen and black dots mark their original positions. Participant has to relocate objects in the correct temporal order and to place them to the correct positions then click on the box labeled 'finished'	In this test, objects will appear on the screen. The number of objects will increase with each trial. **Try to remember both the order and the locations of the objects. After the presentation you have to rearrange them to the same place and in the same order as they were originally.** You will have some practice trials in the beginning.

Running tasks

To run the tasks on your computer you will need to have Java installed which is a free software, you can download it from here:

http://java.com/en/download/index.jsp

Customization of tasks

You can find three buttons in the header of the box:

- **Calibration** (left side) You need to calibrate your monitor before you run the tasks on your computer because the program calculates the spatial errors in pixel (distances in pixel could differ between different monitors). To perform calibration click on the box in the left side of the header. A square will appear on the screen. Measure the size of the square and save this value. By this procedure your results will be comparable with results from another computer.
- **Descriptions** (center) Here you can find the descriptions and instructions of all the above presented tasks.
- **Contacts** (right) it includes the names and e-mail addresses of the software developers.

In the box below you can set the parameters for your experiment:

- **line1** (*Identification*) Here you can give the name or a code word for the participant.
- **line2** (*Task selection*) Here you can select the task which you would like to run.

- **line3** (*Position marking*) Mark the box if you would like to use dots in the recall phase which show the positions of previously presented objects. If you don't need position marking in spatial tasks leave this box empty.
- **line4** (*Practice trials*) Mark the box if you would like to use practice trials before tasks. If you select this option, tasks will start with two practice trials (you can select the number of pictures within the practice trials later). The output file doesn't include the results of these trials.
- **line5** (*Number of pictures in practice trials*) Here you can give the number of pictures within the practice trials.
- **line6** (*Number of pictures in the first trial*) You can give here the number of pictures within the first experiment trial. The number of items increases by one item in each following trial.
- **line7** (*Highest number of pictures*) Here you can give the highest number of presented items. The task will finish at this level even if the participant hasn't exceeded the error limit.
- **line8** (*Highest number of errors*) Error limit is the number of errors which are permitted within a trial. If the participant exceeds this limit the task ends automatically.
- **line9** (*Margin of error in pixel*) This is the highest distance from original presentation position which is permitted in spatial tasks' recall phase. If the participant exceeds it in spatial tasks the program will detect spatial error.
- **line10** (*Presentation time in serial tasks (ms)*) Here you can give the time of the presentation in serially presented tasks. Each item appears sequentially for this predefined time period.
- **line11** (*Presentation time in simultaneous tasks (ms)*) Here you can give the time of the presentation in simultaneously presented tasks. All items appear simultaneously for this predefined time period.
- **line12** (*Target group*) Finally, here you can select the target group of your experiment. You can select from the options 'Adults' and 'Children'. In children version tasks end by displaying colored stars.

After you have given all these obligatory parameters press the button in the bottom of the box labeled 'start'.

The experiment

At first the name of the selected task appears, if you would like to run it, press 'ENTER'.

Then you will see the instructions for the task. After the participant has read the instructions (or listened it in case of children), press 'ENTER' again, so the task will start.

Before each trial a countdown directs the attention to the screen.

At the end of each trial the participant has to click on the box labeled 'finished' in order to start the next trial.

At the end of the tasks a message appears on the screen ('Thank you for your participation') for adults or a colored picture with stars for children.

If you would like to exit task before it ends, press Ctrl+Alt+Esc.

Output file

In the output file, you can find the participant's results for all trials of the task. The document shows the correct order and/or positions in each trial and the answers given by the participant.

Based on this data, you can easily summarize the participant's errors or hits. Furthermore, by the highest number of presented items you can get the participant's memory span in the task (in case if you would like to assess memory span by a predefined error limit).

4. Imitation as a method for studying memory in non-verbal children

Created by Fruzsina Elekes and Ildikó Király
Last modification: 2013.06.04.

Theoretical background

Examining the cognitive abilities of preverbal infants poses great methodological challenges for research. This challenge is especially pronounced in assessing the development of memory systems as in this field the adult experimental tradition relies heavily on introspection. In our summary we discuss a nonverbal paradigm, delayed imitation, that has the potential to differentiate between the declarative – procedural (Cohen and Squire, 1980)[1] memory systems and possibly between the semantic and episodic subsystems of the declarative memory (Tulving, 1985)[2].

Declarative and procedural memory systems

The declarative memory system enables the conscious recollection of facts and episodes, the information that is retrieved by it can be the subject of mental operations. This system allows us to represent and model our environment, and accordingly the content of a declarative memory might be true or false. Information that is stored by the declarative memory is flexible in the sense that it can be retrieved in contexts and modalities differing from that of the acquisition – the information can be generalized (Squire, 2004)[3]. The procedural system enables us to adapt to the environment efficiently by retaining the links between patterns of stimuli and behavioral responses (Tulving, 1985). This implicit knowledge is gradually formed by multiple repetitions, its content cannot reach consciousness and cannot be verbalized. For this reason, this form of memory if often termed learning by the naïve psychology (Squire, 2004).

The first major question regarding memory development is when in the course of development the declarative system emerges in addition to the procedural, implicit memory. Childhood amnesia, the phenomenon that people cannot recall memories from the first years of their lives (Nelson and Fivush, 2004)[4] provides an applied psychological motive to this question. Does the existence of childhood amnesia imply that no consciously accessible memories are formed during this period of life that is otherwise featured by quick learning? Based on cumulating empirical evidence the answer to this question is a definite no! The appearance of declarative memory in ontogeny might precede the emergence of verbality, necessitating the establishment of paradigms with which we can determine whether the memory a) was quickly acquired, b) is consciously accessible, and c) is featured by the representational flexibility that makes generalization possible, based on the mere observation of child's nonverbal behavior. Delayed imitation is a good candidate.

[1]Cohen, N. J. and Squire, L. R. (1980). Preserved Learning and Retention of Pattern-Analyzing Skill in Amnesia: Dissociation of Knowing How and Knowing that. Science, New Series, Vol. 210, No. 4466, pp. 207-210.
[2]Tulving, E. (1985). How Many Memory Systems Are There? American Psychologist, Vol. 40, No. 4, 385-398.
[3]Squire, L. R. (2004). Memory systems of the brain: A brief history and current perspective. Neurobiology of Learning and Memory, 82, 171–177.
[4]Nelson, K., Fivush, R. (2004). The Emergence of Autobiographical Memory: A Social Cultural Developmental Theory. Psychological Review, Vol. 111(2), 486-511.

Procedure – delayed imitation

The paradigm of delayed imitation gained popularity in memory research through the work of Andrew Meltzoff (1988[5], 1995[6]) that set the traditions regarding both the procedure and the used target objects and actions for decades.

An imitation experiment consists of three phases. The *demonstration phase* begins after the experimenter escorted the child and the parent to the experimental room where the child observes the action sequence to be remembered. Although some imitation studies employ video demonstrations, in the field of memory development usually the experimenter demonstrates the action because during the first 18 months of life the video demonstration might decrease the rate of imitation (Hayne, Herbert, and Simcock, 2003)[7] and this effect is attributable to causes other than memory performance. The action that is presented is usually directed towards a novel object and it involves behavior that is also unknown to the child. The novelty of the action ensures that during testing we indeed measure the effect of a representation (memory) that was formed by observing the demonstration and not the effect of semantic, script-like knowledge the child acquired through prior experience (Meltzoff, 1988). We distinguish arbitrary and enabling action sequences on the basis of the temporal structure of the event (Bauer, 1996)[8]. In arbitrary sequences the order of the action elements is modifiable without any effect on goal achievement (e.g. when making cocoa-drink one can either put cocoa powder or milk in the mug first, Király, 2009)[9]. If however, the desired outcome can only be attained by using a fix order of events we call the action sequence enabling (e.g. the child has to put the toys into the box first and then put the lid on the box when tidying the room).

The demonstration is followed by a *delay phase*. By varying the length of the delay we can tap the capacity of long term memory. It is however, important to note that even after a 10 minute delay recall necessitates long term memory performance! The object that the model manipulated is only given to the child when the *test phase* begins. Thus the child can only imitate the observed action by remembering the demonstration itself not his/her own actions on the object (Meltzoff, 1988). The procedure also contains a pre-demonstration baseline phase (or baseline group), in which the child is allowed to play with the objects, so that we can determine (and control for) the frequency of spontaneously produced target actions. The procedure of Meltzoff (1988) provides an even more rigorous control: in this procedure the control group also observes an object directed demonstration, but this action differs from the target action. This can control for the effect of stimulus enhancement, the phenomenon that merely watching an object being manipulated results in more object directed actions that might include the target action as well without any memory performance involved. There are two major differences between imitation studies of memory development. In the Meltzoff paradigm the demonstration is not accompanied by verbal labeling and the child doesn't receive any direct instructions regarding the "task" during the test phase either. Bauer's lab on the other hand uses the so called elicited imitation paradigm, in which the model verbally points out the aim of the action and narrates the event during demonstration (Bauer, 1996). This manipulation facilitates the formation of goal-centered memories – we will come back to the role

[5]Meltzoff, A. N. (1988). Infant Imitation After a 1-Week Delay: Long-Term Memory for Novel Acts and Multiple Stimuli. Developmental Psychology, Vol. 24, No. 4, 470-476.
[6]Meltzoff, A. N. (1995). Understanding the intentions of others: re-enactment of intended acts by 18-month-old children. Developmental Psychology, 31, 838–850.
[7]Hayne, H., Herbert, J. and Simcock, G. (2003). Imitation from television by 24- and 30-month-olds. Developmental Science, 6: 254–261.
[8]Bauer, P. J. (1996). What Do Infants Recall of Their Lives? Memory for Specific Events by One- to Two-Year-Olds. Americal Psychologist, Vol. 51, No. 1, 29-41.
[9]Király, I. (2009). Memories for Events in Infants: Goal-Relevant Action Coding. In: Striano, T., Reid, V (eds.) Social Cognition Development, Neuroscience, and Autism, Wiley Blackwell, 2009.

of this later. Another feature of the elicited imitation paradigm is that during testing the child is instructed explicitly: e.g. "Now you make a rattle like I did!".

Based on the above description one important feature that is common in imitation paradigms might be noticed: those props, objects that are used during action demonstration are also present at test. One might argue that if the [object – action] information is stored as one memory unit, a priming like implicit mechanism might also result in successful recollection: the presence of one piece of the stored memory might automatically active the rest of the memory trace (McDonough, Mandler, McKee, and Squire, 1995)[10]. Do we have reason to assume conscious, declarative remembering here? Amnesia usually affects the declarative memory system thus if the imitation of object directed actions relies on the implicit system anterograd amnesic patients' imitative performance should be as good as that of the controls'. Examining amnesic people McDonough and colleagues (1995) couldn't find measurable imitative performance. Adlam, Vargha-Khadem, Mishkin, and de Haan (2005)[11] reported imitation in developmental amnesic patients but the rate of imitation was lower than in control subjects. The weak (or non-existent) imitative performance of amnesic people implies the role of declarative memory in imitation. The paradigm hence seems to be suitable to assess the unfolding of this memory system.

Expected results - The unfolding of the declarative memory system

According to Meltzoff (1988) 14 month old infants can reproduce observed, novel behaviors after a one week delay (e.g. turning on a light with their foreheads). Using actions that are simple enough to suit the age group imitation is already detectable in 6 to 9-month-olds after a one day delay even if the model performs six different actions on different objects (Collie and Hayne, 1999)[12]. To measure the developing memory span researchers gradually raise the number of event elements included in the action sequence with age (see Video 1). Although the performance measured in the number of recalled elements continues to increase during the second year of life (Barr, Dowden, and Hayne, 1996)[13], Collie and Hayne (1999) conclude that the basics of declarative memory are at place and working by 6 months of age. Do these results correspond to the criteria of quick learning? According to the standard procedure the model demonstrates the action three times (this ensures that the infant saw it at least once). Six-month-olds need twice as many demonstrations to be able to imitate after a delay (Barr, Dowden, and Hayne, 1996). Thus, although the memory performance is remarkable even after that many repetitions, it is doubtful that the memory that underlies imitation is declarative.

Video 1. Imitation – 10-month-old. [http://www.youtube.com/watch?v=WBWXEYdRhF4]

In order to term it declarative the memory has to correspond to the criteria of representational flexibility as well, that is the child has to be able to use the acquired knowledge in contexts differing from that of the presentation

[10]McDonough, L., Mandler, J. M., McKee, R. D., and Squire, L. R. (1995). The deferred imitation task as a nonverbal measure of declarative memory. Proceedings of the National Academy of Sciences USA, Vol. 92, pp. 7580-7584.

[11]Adlam, A-L., Vargha-Khadem, F., Mishkin, M., and de Haan, M. (2005). Deferred Imitation of Action Sequences in Developmental Amnesia. Journal of Cognitive Neuroscience, 17:2, pp. 240–248.

[12]Collie, R and Hayne, H. (1999). Deferred Imitation by 6- and 9-Month-Old Infants: More Evidence for Declarative Memory. Developmental Psychobilogy, 35(2), 83-90.

[13]Barr, R., Dowden, A., and Hayne, H. (1996). Developmental Changes in Deferred Imitation by 6- to 24-Month-Old Infants. Infant Behavior and Development, 19, 159-170.

(Barnat and Meltzoff, 1996)[14]. This can be tested by experimental situations that require generalization: the context of testing differs from the context of demonstration. The findings of Barnat and Meltzoff (1996) show that 14-month-olds are able to recall the previously acquired information even if the color and size of the target object and the physical environment changes but their performance is lower than it would be in an unchanged context. Investigating representational flexibility a clear developmental trajectory seems to unfold. At the age of 6 months infants are only able to imitate if the context of testing is the exact same as it was during demonstration (Hayne, Boniface, and Barr, 2000)[15], such a lack of generalizability features procedural memory (Diamond, 1990; cit: Meltzoff, 1988). Around their first birthdays changes in the physical context doesn't reduce children's performance any more, but it is still strongly dependent on the invariance of the manipulated object itself. Finally, the ability of the context independent, flexible imitation emerges at the age of 18 months (Hayne, Boniface, and Barr, 2000).

These results indicate that the mature, functional declarative memory develops gradually between the ages of 6 and 18 months: in the meantime the number of necessary demonstrations decreases and the acquired knowledge becomes adaptable to various contexts.

Extended theoretical background - Episodic and semantic memory systems

Declarative memory can be further divided into two subsystems. In the taxonomy put forward by Tulving (1985) episodic memory is the specialized subsystem of semantic memory, which is the specialized subsystem of procedural memory. The first two constitute the declarative memory system. Semantic memory enables us to establish mental models of the world (knowledge) that can be manipulated independently of their behavioral manifestation. Semantic memory is featured by the introspective consciousness of the inner and outer world (the content of the memory is conscious, noetic), but it lacks the consciousness of the personally experienced event, the subjective spatial, temporal framework of the memory. The subjective spatio-temporal framework is the feature of episodic memory. An episodic memory includes the representation of the relation between the event and the identity of the person who experiences it. This kind of memory is characterized by autonoetic consciousness, and during recall the person mentally re-experiences the event.

In Tulving's view (1983, cit: Schwartz, Evans, 2001)[16] not even primates have episodic memory among non-human animals (see Textbox 1). Hence, the second major question regarding the development of memory systems is at what age does the presumably human-specific, episodic system emerge. It is consensual that the delayed imitation paradigm is appropriate to test the functioning of the declarative system. Can we also use imitation to tap episodic remembering?

According to Patricia Bauer (1996) imitation is indeed suitable to test that. She underpins this notion with two strong, but questionable claims. First, she assumes that if someone shows remembering after observing a single event that inevitably reflects episodic remembering. Second, in her opinion the behavioral reproduction of an action sequence is analogous to a verbal report of it, which is the primary measure of episodic memory in adults. If however, we accept the theoretical framework proposed by Tulving including the SPI model (2001)[17], it

[14]Barnat, S. B., and Meltzoff, A. N. (1996). Deferred Imitation Across Changes in Context and Object: Memory and Generalization in 14-Month-Old Infants. Infant Behavior and Development, 19, 241-251.
[15]Hayne, H., Boniface, J., and Barr, R. (2000). The Development of Declarative Memory in Human Infants: Age-Related Changes in Deferred Imitation. Behavioral Neuroscience, Vol. 114, No.1, 77-83.
[16]Schwartz, B. L., and Evans, S. (2001). Episodic Memory in Primates. American Journal of Primatology, 55:71–85.
[17]Tulving, E. (2001). Episodic memory and common sense: how far apart? Philosophical Transactions of the Royal Society London B 29, Vol. 356 No. 1413, 1505-1515.

follows that semantic memories can be formed based on a single demonstration, because semantic processing is the prerequisite of episodic processing. Thus, the fact that children can reenact an action that they saw once doesn't prove more than that they have established a memory that is semantic at the least. Furthermore, verbal recall shows only that the content of the memory is consciously accessible, declarative. Among these memories only those can be termed episodic which have the subjective spatio-temporal framework and can be mentally re-experienced during recall (Tulving, 1985)[18].

According to Clayton, Bussey, and Dickinson (2003[19], see Textbox 1) because of the lack of verbality in certain populations the phenomenological experience of episodic recollection is a priori un-provable. This however, doesn't necessarily mean the lack of episodic recollection in those species. They argue that we can detect episodic-like remembering even in these populations based on non-verbal behavioral responses. The behavior has to prove that the memory 1) is formed based on a single episode, 2) it involves personal temporal framework (the subjective present being the reference point) 3) it retains the what-where-when information in an integrated unit, 4) and this information can be used flexibly. As discussed in section 1.2, being formed based on a single episode, and representational flexibility are the criteria of not only the episodic but more generally of the declarative memory that reaches its full-fledged state after gradual development during the second year of life. Remembering the order of multi-step actions might indicate the retention of the what-where-when information, and this can easily be tested by the delayed imitation paradigm. Thirteen-month-olds have been found (Bauer and Hertsgard, 1993)[20] to possess a fragile memory of temporal structure: their performance differs from baseline only if the structure of the event is enabling. At the age of 16 months they are able to reenact an arbitrary action sequence in the right order. This however, only proves that infants can remember the timing of elements within an episode. The paradigm of delayed imitation doesn't enable testing whether the memory has subjective, personal temporal framework. The food-caching behavior of the scrub jay tells us more in this regard.

It is a well established result found in several age groups that the enabling structure of an event results in more precise evocation of the order of the action elements (Bauer and Hertsgard, 1993; Király, 2009). This effect might originate from the goal-centered nature of early event memories, as the temporal order of action elements is only relevant for goal attainment if the structure is enabling (Király, 2009). Imitative behavior cannot solely be explained by memory processes: the type of verbal context one establishes during presentation determines the kind of information the child pays attention to during encoding (Király, 2009). According to the research of Ildikó Király, if the model emphasizes the goal of the action during demonstration two-year-olds do not imitate the step that is irrelevant to goal achievement (e.g. blowing the flower during planting). If the same action sequence is demonstrated in a general attention grabbing verbal context the rate of imitation of the irrelevant step increases (see Video 2 and Video 3) For more videos on various paradigms, see Appendix). Thus, the lack of imitation of an action element might not reflect the problem of remembering and not even the problem of encoding rather the strategy of encoding that is established by the child's current goals that, in turn are set by the verbal context of the presentation. Moreover, the lack of imitation doesn't necessarily prove the lack of memory either as the existence of a declarative memory doesn't oblige the agent to manifest it behaviorally.

[18]We have to add that the widely used SPI model was put forward after Bauer took a stand, this on the other hand doesn't affect the second argument – counterargument pair.

[19]Clayton, Bussey and Dickinson (2003). Can animals recall the past and plan for the future? Nature reviews – Neuroscience, vol 4, 685-691

[20]Bauer, P. J., and Hertsgaard, L. A. (1993). Increasing Steps in Recall of Events: FactorsFacilitating Immediate and Long-Term Memory in 13.5- and 16.5-Month-Old Children. Child Development, 64, 1204-1223.

Video 2. Imitation – preschool (planting flower model phase). [http://www.youtube.com/watch?v=-9ss4VWKUC4]

Video 3. Imitation – preschool (planting flower imitation phase). [http://www.youtube.com/watch?v=K0afsBKOKZY]

In Hoerl's view (2008)[21] up till a certain age children (and other non-human species) can't form episodic memories because they cannot handle time itself – they do not possess "temporal thought". On the face of it, it may seem that this contradicts young infants' ability to remember the temporal order of action elements. But according to the theory proposed by Hoerl, a model of the world that is updated from time to time is sufficient to do that. Let's get back to the example of the scrub jay! To be able to determine whether the worm was still edible the jay doesn't have to remember when it hid the worm. It is sufficient to know how long the jay has the belief/knowledge that 'there is worm at X'. If this time interval exceeds that of the edibility of the worm, the jay deletes this belief of its mental model. Consequently, the jay never has the belief that 'there was worm at X'. This model can explain those patterns of behavior that indicate that the child is oriented in time, while it doesn't expect the child to have memories with subjective temporal framework.

In Hoerl's opinion (2008) the possibility to have episodic memories only arises when the child is able to reason about the temporal order of events. As the performance in all experimental situations of memory can be explained by a knowledge-based model of the world, verification of episodic remembering exceeds the scope of the delayed imitation (or any other memory) paradigm. The best research strategy is to explore when those cognitive abilities that enable the formation of episodic memories (like temporal thought) emerge.

Table 4.1. Textbox 1. Definitional issues on the basis of comparative psychological research.

Assessing the memory capacity of non-human animals poses very similar methodological problems as infant research does. Although Tulving (1983, cit: Schwartz, Evans, 2001) presumed episodic memory to be a human-specific ability, the possibility of an episodic memory has been put forward in some other species. One example is the scrub jay. This type of bird caches the food it finds and returns to the hiding place later. It eats two kinds of food: peanuts (non-perishable) and wax worms (perishable), but they prefer the worms. Clayton and Dickinson (1998) let the birds cache both kinds of food, then removed the birds from that area and varied the length of time after which the they could recover the food (before or after the worms perished). The scrub jays were found to take into account the time that had elapsed since the caching of the food items: they went to the place where the worms were hidden if they were still edible, but recovered the peanuts first if the worms had already perished. This indicates that the scrub jay can handle the passing time in relation to the present (Clayton and Dickinson, 1998)[1]. The subjective spatio-temporal framework is the feature of episodic memories (Tulving, 1985), but based on the behavior of the scrub jay we have no information whether remembering was accompanied by the phenomenological experience of episodic recollection in the jays. For this reason Clayton and colleagues attribute "episodic-like" memory processes to the scrub jay. They suggest that in order to examine episodic memory in non-human animals we need a definition that is adjusted to the characteristics of these species, as some criteria of the episodicity proposed by Tulving can not be tested in these populations. According to the reduced definition episodic memories store information on events that have only been experienced once: on the one hand the time the event took place, on the other hand the spatio-temporal relations between various event elements. It is important to stress that the episodic-like

[21]Hoerl, C. (2008). On Being Stuck in Time. Phenomenology and the Cognitive Sciences, 7(4), pp. 485-500.

memory stores the different aspects of an event (what happened where and when) in an integrated fashion. The information retained in this spatio-temporal framework can be used flexibly in novel situations (Clayton, Bussey, and Dickinson, 2003).

[1]Clayton, N. S. Dickinson, A. (1998). Episodic-likememory during cache recovery by scrub jays. Letters to Nature, Vol. 395, 272-274.

Appendix

There are multiple paradigms that are suitable to test some aspects of memory development.

1. Delayed imitation is a widespread method for many reasons. By varying the length of the delay, the number of action elements and the temporal structure of the event, this method can be used to test different age groups and also to examine other social learning phenomena like the effect of the model's characteristics on knowledge acquisition. See the related videos:
   a. Imitation – 10-month-old. [http://www.youtube.com/watch?v=WBWXEYdRhF4]

   b. Imitation – 2-year-old. [http://www.youtube.com/watch?v=hSjLDOPC6mk]

   c. Imitation – preschool (planting flower model phase). [http://www.youtube.com/watch?v=-9ss4VWKUC4]

   d. Imitation – preschool (planting flower imitation phase). [http://www.youtube.com/watch?v=K0afsBKOKZY]

2. During the first year of their lives infants' memory capacity can be measured by habituation tasks as well. Although they do not speak yet and their motor development is at an early stage infants can actively control the target of their gaze, they only look at things that are interesting to them. Interesting things are the novel or unexpected stimuli. This way the length of looking at a stimulus is indicative of its level of novelty to the child. In a habituation experiment the child is first habituated to a stimulus: the same event is presented to him till the length of looking at the event drops below the half of the looking time to the first demonstration. We can vary the length of the delay between habituation and test and measure whether infants can still remember the previously seen stimulus. If they do they look longer to a novel than to the habituated stimulus. We can also measure infants understanding of the presented event. In this case during test both test-stimuli are novel on a perceptual level, but one of them corresponds to the content of the habituated event (event A), while the other contradicts it (event B). If infants developed an expectation based on the habituation event they do not dishabituate (look longer than the habituated looking time) to event A, but they do dishabituate to event B. The familiarization procedure is the modified version of habituation: in this case the event is presented to the infant only a few times. The number of repetitions is predetermined and doesn't depend on the looking behavior of the infant (see Video 8).

   Video 8. Familiarization – 10-month-old. [http://www.youtube.com/watch?v=7cTb2TUKocg]

3. A relatively novel tool for assessing the cognitive abilities of infants (and adults!) is eye-tracking (see Video 9). During an eye-tracking study the participant watches pictures or videos on a monitor. For each time point the eye-tracking system can identify the exact direction of the participant's gaze. The procedure starts with a calibration phase in which an attention grabbing image appears on five different points of the screen – this ensures that the eye-tracker can adjust its general model of the human eye to that of the participant and can provide valid data afterwards. The principle behind infant eye-tracking studies is that by analyzing the lengths of looking or the direction of gaze we can determine what expectations infants form while watching the stimuli. The phenomenon of anticipatory looking is a good example: quite often the movements of our eyes precede the actual appearance of an event. If the child looks at one out of two possible outcomes before the model actually performs the action, we can conclude that the child had an expectation of its occurance. This general paradigm can be used to test social and cognitive abilities, including memory development as well.

Video 9. Eye-tracking – 10-month-old. [http://www.youtube.com/watch?v=atBZE0o8AU0]

5. Methods of study personal autobiographical memories

Created by Ágnes Sz#ll#si, Anikó Kónya
Contact: aszollosi@cogsci.bme.hu
Last modification: 2013.07.18.
Experimental software: PsychoPy
Package name: V_pam.zip [http://pszichologia.elte.hu/eltetamop412A1/ronam/V_pam.zip]

Theoretical background

In autobiographical memory research one of the most widely used methods is the so called "cue word recall" method. This technique is originally introduced by Galton in 1883[1], and then modified by Crovitz and Schiffman in 1974[2]. The modified version of this method is still used today, because this technique is particularly effective in improving the recall of vivid autobiographical memories. In a typical cued recall task, words are presented to the participants (e.g. in the middle of a computer screen), and their task is to recall one personal memory in response to one cue word. The selection of the cue words is determined by the aim of the study. For example, in studies on emotional memories (e.g. Williams and Broadbent, 1986)[3] experimenters usually ask the participants to recall memories in response to negative or positive words assuming that emotional cues evoke emotional memories. Cue words are usually selected from standard databases (e.g. Rubin and Friendly, 1986)[4], including words and their properties (for example emotional valence, frequency etc.). Using the cue word recall method is a good way to investigate the characteristics of autobiographical memory. For example, a series of studies (e.g. Fitzgerald and Lawrence, 1984[5]; Fitzgerald, 1988[6]) proved that this technique is suitable for investigating the distribution of autobiographical memories across the lifespan (e.g. childhood amnesia, reminiscence bump etc.). Sometimes experimenters calculate the amount of time elapsed between the presentation of the cue word and the retrieval (reaction time). Autobiographical memory researchers (e.g. Conway and Pleydell-Pearce, 2000[7]; Conway, 2005[8]) usually make a distinction between direct and generative retrieval. The latter way requires more effort and it takes longer. Therefore the type of the retrieval mode can be deduced from the reaction time (e.g. Haque and Conway, 2001)[9].

The cue word recall is not the only one way to collect autobiographical memories; the recall process can be helped in other ways. In a study Barsalou (1988)[10] asked the participants to recall memories from the

[1]Galton, F. (1883). Inquires into human faculty and its development. Everyman Edition, London, Dent.
[2]Crovitz, H. F., and Schiffman, H. (1974). Frequency of episodic memories as a function of their age. Bulletin of the Psychonomic Society, 4, 517-518.
[3]Williams, J. M. G., and Broadbent, K. (1986). Autobiographical memory in suicide attempters. Journal of Abnormal Psychology, 95, 144–149.
[4]Rubin, D. C., and Friendly, M. (1986). Predicting which words get recalled: Measures of free recall, availability, goodness, emotionality, and pro-nunciability for 925 nouns. Memory and Cognition, 14, 79–94.
[5]Fitzgerald, J. M., and Lawrence, R. (1984). Autobiographical memory across the lifespan. Journal of Gerontology, 39, 692–698.
[6]Fitzgerald, J. M. (1988). Vivid memories and the reminiscence phenomenon: The role of a self narrative. Human Development, 31, 261–273.
[7]Conway, M. A., and Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. Psychological Review, 107, 261-288.
[8]Conway, M. A. (2005). Memory and the self. Journal of Memory and Language, 53, 594-628.
[9]Haque, S., and Conway, M. A. (2001). Probing the process of autobiographical memory retrieval. European Journal of Cognitive Psychology, 13, 1–19.
[10]Barsalou, L. W. (1988). The content and organization of autobiographical memories. In U. Neisser and E. Winograd (Eds.), Remembering reconsidered: Ecological and traditional approaches to the study of memory (pp. 193-243). Cambridge: Cambridge University Press.

last summer. Rubin and Wenzel (2005a[11]; 2005b[12]) reviewed six autobiographical memory methods: Life Narrative; Involuntary Memory Diary; Autobiographical Memory Interview; Diary Recall and Questionnaire. For example, in a study using the life narrative method Fitzgerald (1992) asked his participants to recall significant events from their pasts in a monologue. Whichever method is used, experimenters usually ask the participants to tell or to write down the retrieved memory. Important conclusions can be drawn from the content of a memory. Furthermore, participants can be asked to rate the phenomenal qualities (e.g. vividness, emotional intensity, personal importance) of the memories on Likert scales (e.g. from 1 to 5). There are standard questionnaires (e.g. the Memory Characteristics Questionnaire, MCQ; Johnson, Foley, Suengas, and Raye, 1988)[13], which were developed to measure a wide range of phenomenal qualities of past (and future) events.

Procedure

Running the program (PersonalAutobiographicalMemory.py) provides an opportunity to collect autobiographical memories. The main advantage of this program is that you can compile your own experiment. For example, you have the chance to ask the participants to recall memories in response to cue words. In this case, you have to customize the following part of the experiment: the number of the cue words, the cue words itself, the order of the presentation (random or sequential) and the presentation time of the cue words. If you would not like to use cue words, you have to help the recall process in other ways (e.g. specify lifetime periods). Therefore you have to specify your own instruction (e.g. Please recall a memory from the last summer!). Furthermore you have the chance to ask the participants to rate the phenomenal characteristics (e.g. general vividness, time, location, emotions, thoughts, importance) of the retrieved events. You can use the default questions we specified, or you can specify your own questions.

In addition to this guide, the package consists of the following files: PersonalAutobiographicalMemory.py; cues.txt; time_order.txt; spec_instruction.txt; phenomen.txt; settings.txt; JohnSmith_1978.xls. In order to get the experiment to run, all files must be saved in the same folder.

Right after you have started to run the program (AutobiographicalMemory.py), the program asks you whether you would like to run the experiment with the last settings or not. If it is not the first time you run the experiment, and you would like to use the very same settings as last time, answer "yes"! Otherwise, answer "no" and customize the experiment!

Customization of the experiment

I.) The experiment begins with a pop-up window (so-called dialogue box) with the title of "Customization of the experiment" (see Figure 1). Certain information must have been provided before the experiment begins:

- **Line 1:** In the first line of the pop-up window you can read the text of the default general instruction, but you can replace it with your own, if necessary. Although it seems that the textbox is too small, the text of the instruction can be any length.

[11]Rubin, D. C., and Wenzel, A. (2005a). Autobiographical memory research: Six common methods. In D. C. Rubin, and A. Wenzel (Eds.), Cognitive methods and their application to clinical research (pp. 215-217). Washington, DC: American Psychological Association.
[12]Fitzgerald, J. M. (1992). Autobiographical memory and conceptualization of the self. In M. A. Conway, D. C. Rubin, H. Spinnler, and W. A. Wagenaar (Eds.), Theoretical perspectives on autobiographical memory (pp. 99-114). Boston: Kluwer Academic Publishers.
[13]Johnson, M. K., Foley, M. A., Suengas, A. G., and Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. Journal of Experimental Psychology: General, 117, 371-376.

- **Line 2:** Next question is about whether you want to use cue words or not (yes/no).

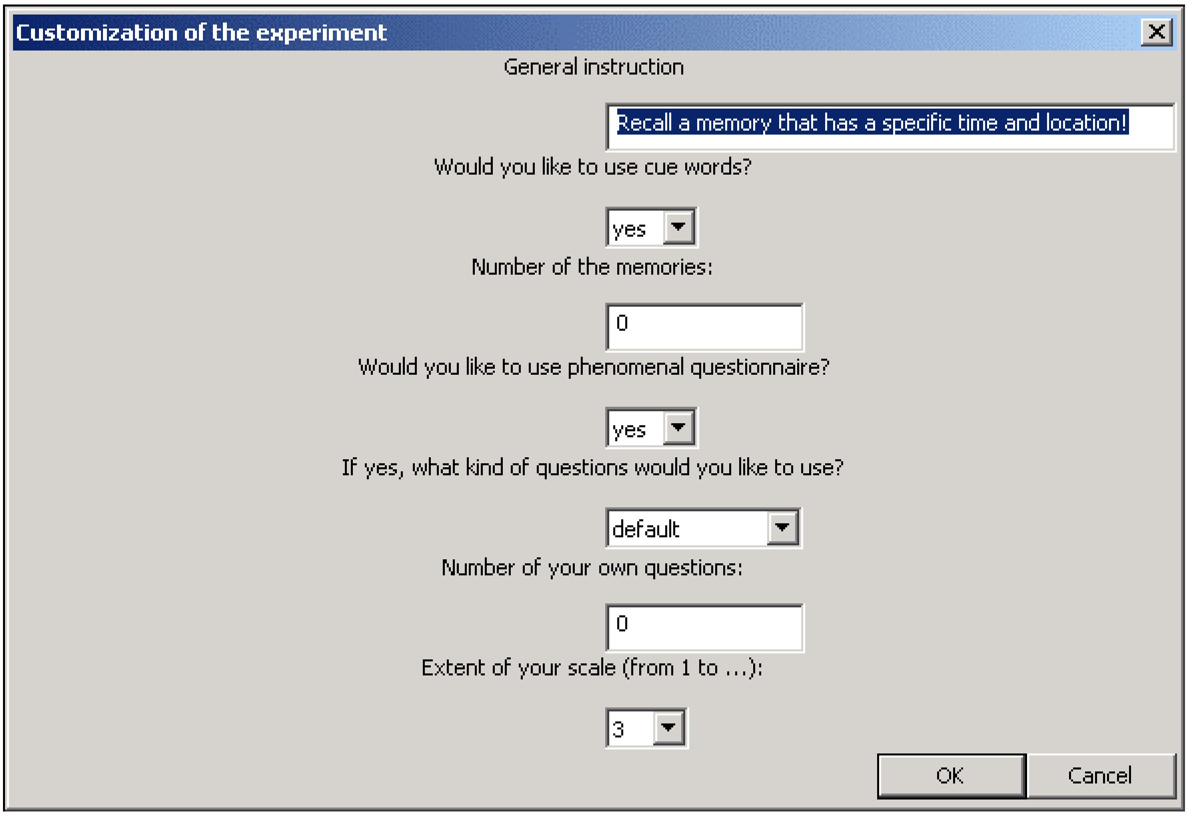
- **Line 3:** Then you have to enter the number of memories you want the participant to recall. In experiments on autobiographical memory, participants traditionally recall only one memory in response to one cue word. Therefore if you chose cue words to use, the number of the memories and the number of the cue words are the same. If you would not like to use cue words, you have to enter the number of the memories you want the participant to recall. Later you have to specify your own instruction for each memory in the next dialogue box.

- **Line 4:** Then you need to decide whether you would like to ask the participant to rate the phenomenal characteristics of the retrieved events or not (yes/no).

- **Line 5:** If you want the participant to rate the phenomenal qualities of the events, two options are available. You can use the default questions we specified, or you can specify your own questionnaire (default/own questions). For the default questionnaire see Appendix. This questionnaire is based on the result of the factor analysis (Sz#ll#si, Fazekas, and Kónya, 2013)[14] on the modified Hungarian version of the Memory Characteristics Questionnaire (MCQ; Johnson et al., 1988).

- **Line 6 and 7:** If you would like to use your own phenomenal questions, you have to enter the number of the questions and the extent of the scale. (If you would like to use the default questionnaire, skip line 6 and 7! The program is going to use the default values.)

Press the "OK" button to close the pop-up window and to continue!



[14] Sz#ll#si, Á., Kónya, A., and Fazekas, K. (2013). Autobiographical memory: Experience and narrative. Pszichológia, 33(3). (accepted publication) [Hungarian]

Figure 1. Customization of the experiment.

II.) Depending on whether you would like to use cue words or not, there are to possible ways:

II./1.) **If you would like to use cue words,**

- the program continues with another pop-up window with the title of "Cue words" (see Figure 2): at first, you have to specify the presentation time (in seconds) of the cue words. The default presentation time is 2 seconds, but this can be replaced.
- Then you need to decide whether you want to present the cue words in random order or not (random/ sequential). If you choose the option "sequential", the cue words will follow each other in the same order you will enter them in the next dialogue box.
- After the "OK" button has pressed, you have to specify the cue words itself in the next dialogue box (see Figure 3). Type only one word in a line!

Press the "OK" button to continue!

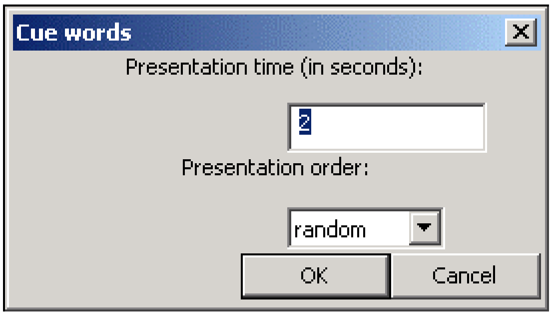


Figure 2. Cue words: presentation time and order.

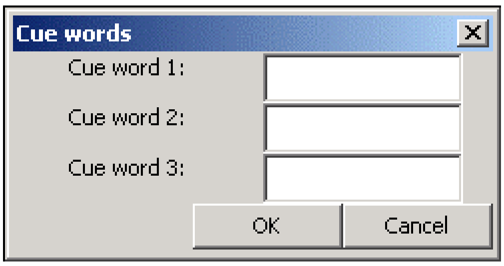


Figure 3. Cue words.

II./2.) **If you would not like to use cue words**, the program continues with a pop-up window with the title of "Special instructions" (see Figure 4). Here you have to specify your own instructions for each the memory you want the participant to recall (e.g. life-time periods). For example, if you want the participant to recall three memories from three lifetime periods, you have to specify each of the three instructions (e.g. Recall a memory from your childhood!; Recall a memory from your teenage years!; Recall a memory from the last year!). Type only one instruction in a line! The instructions are going to appear in the same order as given here. Press the "OK" button to continue!

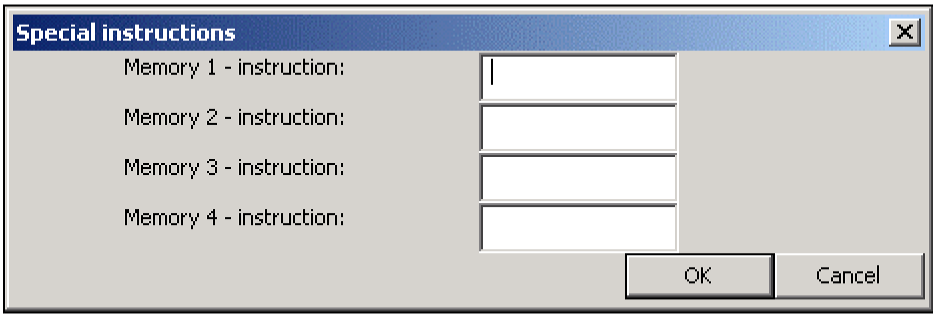


Figure 4. Special instructions.

III.) Finally, if you want to use your own phenomenal questions, you have to enter them in the next dialogue box (see Figure 5). Type only one question in a line! Don't forget to indicate the extent of the scale after the question (e.g. The general vividness of the event: 1 – vague … 7 – very vivid)!

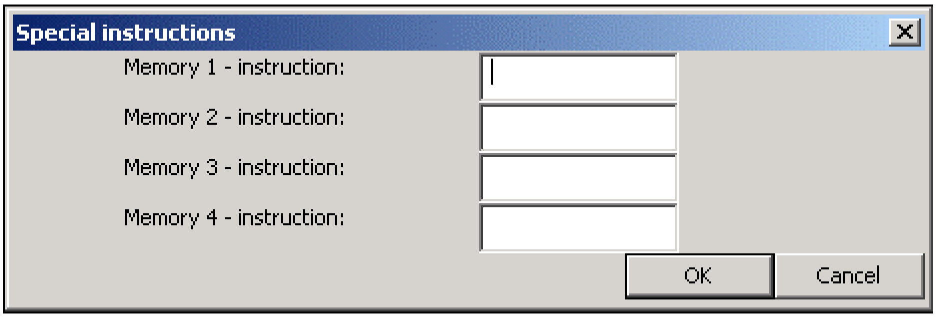


Figure 4. Phenomenal qualities.

Press the "OK" button to finalize the customization process! The experimenter has no more to do. (Note: the experimental settings are saved to the following files: settings.txt, cues.txt, time_order.txt, spec_instructions.txt and phenomen.txt. Please don't remove these files!)

The experiment

- After the "OK" button has pressed, the following text appears in the middle of the screen: "If you are ready, press any key to start the experiment!"

- After any button has pressed, a pop-up window appears on the screen with the title of "Demographic data". The participant has to enter the following data before the experiment begins: name (or code word), birth year, sex (male/female), education, test date (format: year.month.day) and test time (format: hour:minute). The participant has to press the "OK" button to continue.

- The experiment begins with the general instruction presented in the middle of the screen. The participant has to press any button to continue.

- Depending on whether you would like to use cue words or not, there are two possible ways:

  1. If you chose cue words to use, after any button has pressed, the first cue word appears in the middle of the screen.

     - After the word has disappeared, the participant has to press any button when a memory comes into his or her mind. The program allows us to measure the time elapsed between the disappearance of the stimulus and the keypress. This reaction time (in sec) is automatically saved and written to the output file.

- The experiment continues with another pop-up window. The participant's task is to type the content of the retrieved event and to specify how old he or she was when the event took place. Although it seems that the textbox is too small, the description of the memory can be any length. The participant has to press the "OK" button to continue.

2. If you did not choose cue words to use, right after the instruction has been presented on the screen and the participant has pressed any button, he or she is asked to write down the content of the event (the description of the memory can be any length) and to specify how old he or she was when the event took place.

- If you chose to ask the participant to rate the phenomenal characteristics of the recalled events, the experiment continues with a dialogue-box. Here, the participant has to rate the phenomenal characteristics of the events.
- After the last question has been answered, the participant has to press the "OK" button!
- After that, the following sentence has been presented on the screen: "You can have a break. If you are ready to go to the next memory, press any key to continue!" Then the experiment continues with the retrieval of the next memory.

Output file

Each participant's answers are saved in a separate text file into the folder of the program (AutobiographicalMemory.py). The fields of data are tab-delimited. The name of the output file consists of the name (or code word) and the birth year of the participant separated by an underscore (_). To see a sample output file, open "JohnSmith_1978.txt".

- In the output file, you can find the demographic data specified by the participant at the beginning of the experiment:
  - name (or code word)
  - birth year
  - sex (male/female)
  - education
  - test date (format: 'year.month.day')
  - test time (format: hour:minute)
- If you chose cue words to use, the demographic data are followed by the first cue word. This may differ between participants, because cue words could follow each other in random order. In the next cell, you see the reaction time (in sec) belongs to the first word. This is followed by the description of the first memory and the participant's answer regarding to the time, when the event took place.
- If you did not choose cue words to use, the demographic data are followed by the first instruction. In the next cell, you see the reaction time (in sec) belongs to the first memory. This is followed by the content of the first memory and the participant’s answer regarding to the time, when the event took place.

- This is followed by the participant's ratings, if you asked him or her to rate the phenomenal characteristics of the events.

Appendix

Phenomenal characteristics – default questionnaire:

1. The overall vividness of the event is 1 – vague; 7 – very vivid
2. The time when the event takes place is 1 – vague; 7 – clear/distinct
3. The location where the event takes place is 1 – vague; 7 – clear/distinct
4. Feelings at the time when the event took place were 1 – not intense; 7 – very intense
5. This event has serious implications 1 – not at all; 7 – definitely
6. The event involves visual details 1 – little or none; 7 – a lot
7. The event involves sounds 1 – little or none; 7 – a lot
8. Do you have any doubts about the accuracy of this event? 1 – a great deal of doubt; 7 – no doubt whatsoever

(Supported by TÁMOP 4.1.2.A/1-11/1-2011-0018 and the National Scientific Research Foundation, Hungary, K81641)

Készült az Új Széchenyi Terv TÁMOP 4.1.2.A/1-11/1-2011-0018 sz. projektje keretében.

ÚJ SZÉCHENYI TERV

MAGYARORSZÁG MEGÚJUL

A projekt az Európai Unió támogatásával, az Európai Szociális Alap társfinanszírozásával valósul meg.