Cognitive Psychology
Experiments Demonstrations

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Cognitive Psychology Experiments Demonstrations

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This is a repository of freely usable psychological experiments. You can use it to try the psychological phenomena for yourself. Also, you can modify the code to build your own experiment.

TÁMOP 4.1.2.A/1-11/1-2011-0018

Table of Contents

1. How to run the experiments?

1.1. Install the experiment control software

For running the experiments you need an experiment control software. The experiments on this site use either PsychoPy or OpenSesame experiment control software. You'll find in all descriptions of the experiments which software is needed to run the experiment.

To run any experiments, first you have to install the appropriate experiment control software. If you use OpenSesame, download and install it from here [http://osdoc.cogsci.nl/].

1.2. Install and run a PsychoPy experiment

Running a PsychoPy experiment

(This document is for novice PsychoPy users who want to run an experiment but not want to build their own (yet). If you consider developing your experiment, see a more technical documentation on the PsychoPy website [http://www.psychopy.org/].)

To run a PsychoPy experiment, first you should install PsychoPy. Then, copy the file(s) of the experiment to your computer. Finally, you can run the experiment. Here is how to do this.

Installing PsychoPy

- If you use Windows or Mac, download the installer from here: http://code.google.com/p/psychopy/. On the left side of the page find Featured downloads. Choose the .exe file for Windows, or .dmg file for Mac. After downloading the file install it the usual way.
- If you use Linux, you can download and install it from the repository of your distribution. If you use Debian or Ubuntu Linux, then use the neurodebian repository for the latest version: http://neuro.debian.net/

Running PsychoPy

After a successful installation the PsychoPy icon is available in your start menu or dock with which you can start PsychoPy.

Two main windows of PsychoPy

PsychoPy has two main windows. The Builder window is appropriate to show the structure of an experiment graphically (see Figure 1).

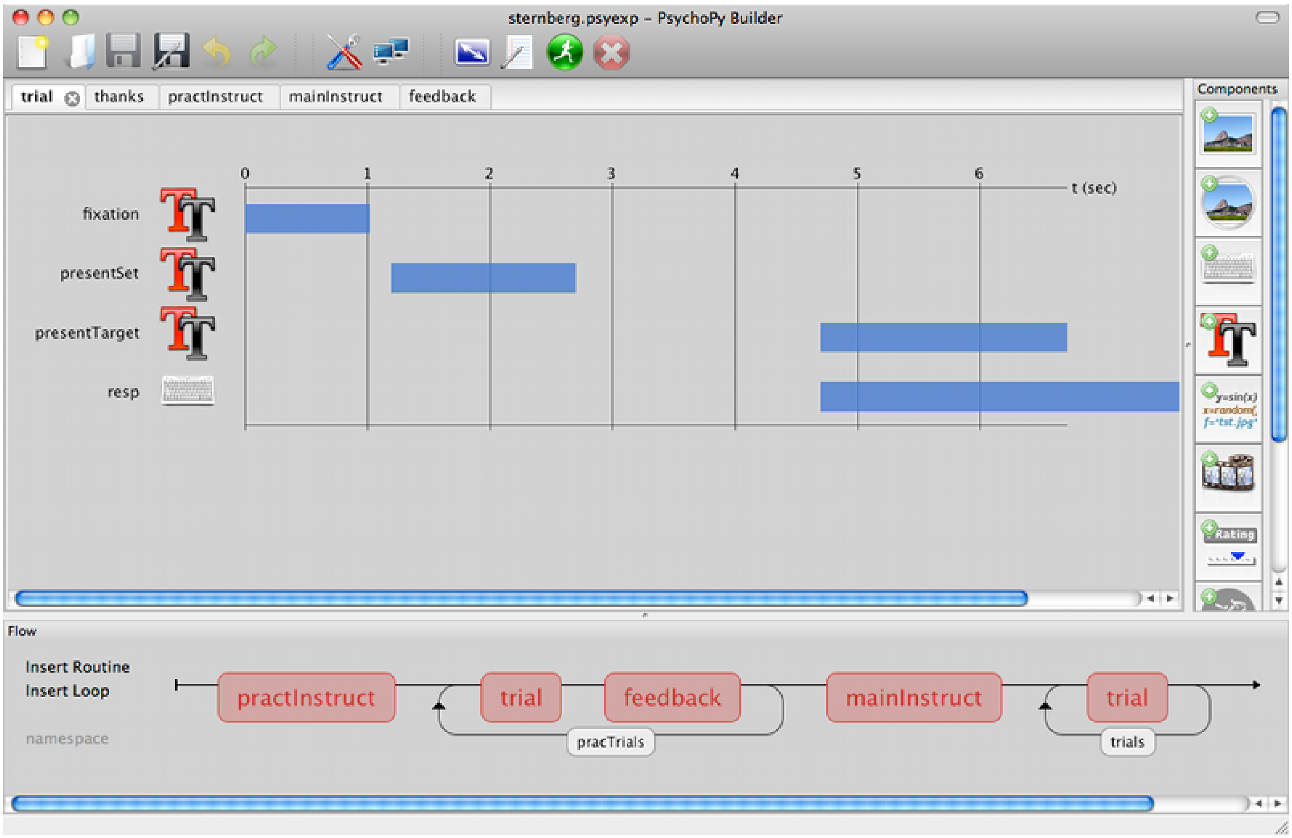


Figure 1.

In the Coder window you can see the experiment as a program code (see Figure 2).

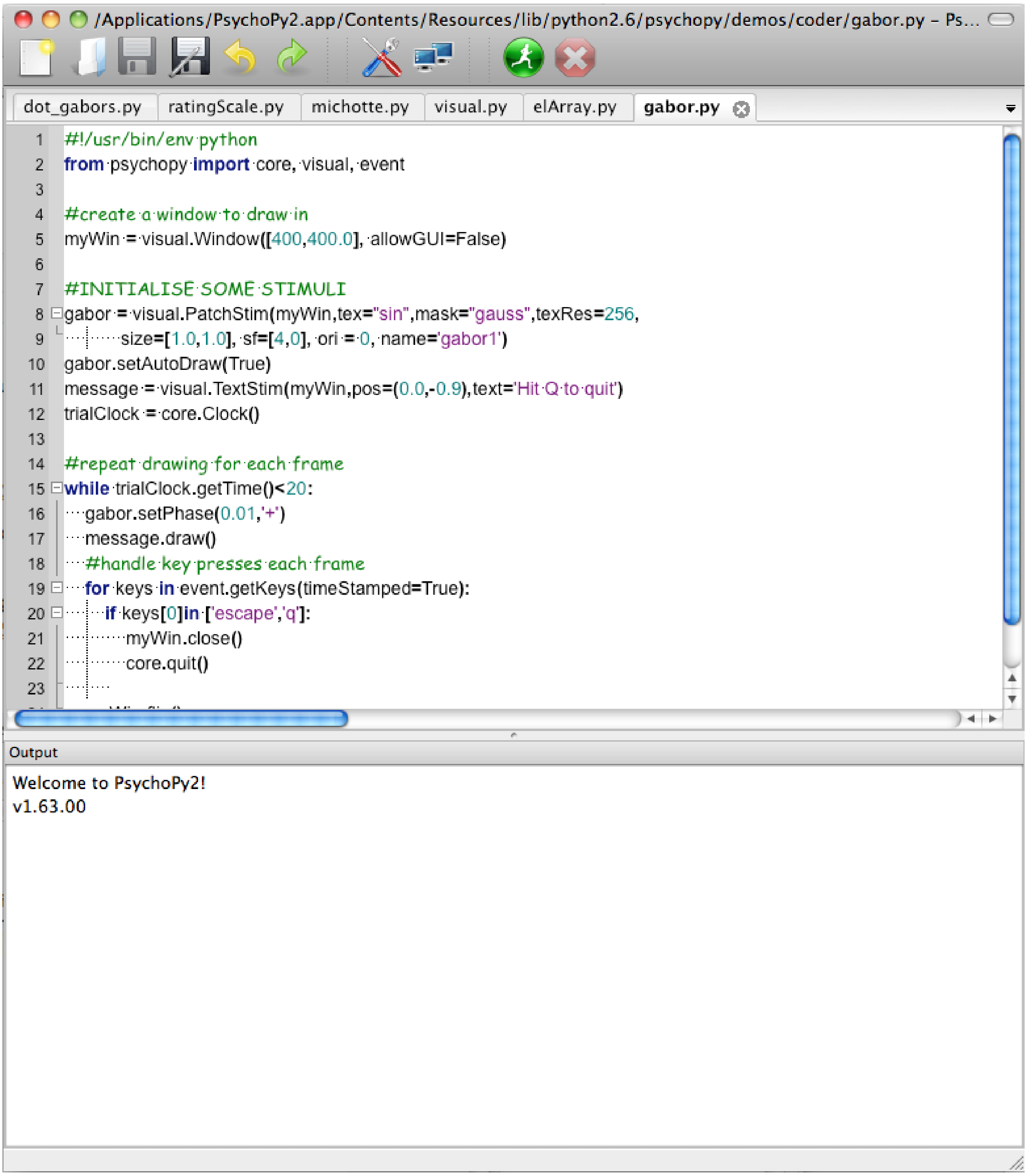


Figure 2.

Choosing the appropriate window

Some experiments (with the .psyexp extension at the end of the filename) can be opened from the Builder window, while some other experiments (with the .py extension at the end of the filename) can be opened from the Coder window.

- If you have .psyexp experiment, use the Builder view.
- If you have .py experiment, use the Coder view.

If only one of the windows is visible and you want to switch to the other window, use the *View* > *Open code view* command or the *View* > *Go to builder view* command.

Place your experiment on your computer

Copy the files of the experiment to a folder on your computer. If you have a compressed file (e.g. with .zip or .gz filename ending), then uncompress all files to a folder.

Open and run your experiment

Opening the experiment

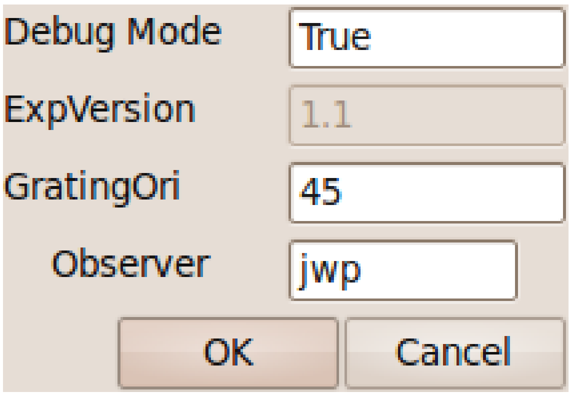
- Use File > Open command or Ctrl+O shortcut or the Open icon on the toolbar. Choose the appropriate file.
- You can also drag the appropriate file to the PsychoPy window.
- Double clicking on the .py file will **not** be opened by PsychoPy.

Running the experiment

Run the experiment with the Tools > Run command or with the Ctrl+R shortcut, or click on the green running man icon on the toolbar.

Setting some parameters

At the beginning of some experiments a window appears where you can set some parameters of the experiment. The description of the experiment can help you what these settings mean.



Results of the experiment

Sometimes the experiment program might display your result on the screen either in text or in graphs.

Sometimes (almost all the time) the results can be found in a separate file.

- The file is usually in your folder where the experiment file itself can be found. If the file is saved somewhere else, then the documentation of the experiment can tell you where it is.
- The file is usually a text file or a file that can be opened with a spreadsheet software (e.g. LibreOffice Calc, MS Excel, Google Spreadsheet, etc.), and it ends with .txt, .csv,. log or .xlsx. If the file uses a different format, then you can read about it in the experiment description.
- The filename usually contains the id or name of the participant.

- Usually the file includes all the trials: every row is a trial, and it includes many data of that trial (e.g., what stimuli were shown, what the participant's response was, what the reaction time was, etc.). The documentation of the experiment can tell you what information you will find in the result file.

Reporting errors

If you run into an error, you might ask for some help. In order to help you finding the source of an error the following three pieces of information is needed. Send these infos to someone who could help you with solving the problem.

- First, describe how the program stopped or what did it do wrong? What did you expect to happen and what did it happen instead? Try to be as specific as you can.
- Second, if you got an error message at the bottom part of the PsychoPy window, called Output pane, then copy the error message.
  - You will see something like this:

```
Problem compiling: [Errno 13] Permission denied:
'/usr/local/lib/python2.6/dist-packages/PsychoPy-1.62.00-py2.6.egg/psychopy/demos/coder/GUI.pyc'
##### Running:
/usr/local/lib/python2.6/dist-packages/PsychoPy-1.62.00-py2.6.egg/psychopy/demos/coder/GUI.py
#####
```

  - Copy all the text that is the result of the run.
    - If you tried to run the experiment only once since you opened PsychoPy, then copy the whole content of the Output pane.
    - If you tried to run the experiment several times, then copy only the output text of the last run. This text usually starts with the "##### Running: " part.
- Finally, run a diagnosis script, which can be opened from Demos > Experiment control menu, and it is called sysInfo.py. After clicking on that menu command, a PsychoPy script will be opened, which can be run (Tools>Run or Ctrl+R or clicking on green running guy on the toolbar). After a couple of seconds a text message will be printed to the Output pane at the bottom of the PsychoPy window. Copy that text beginning with the "System info" text.
  - It will look something like this:

```
System info:
Linux-2.6.31-22-generic-x86_64-with-Ubuntu-9.10-karmic

Python info
/usr/bin/python
2.6.4 (r264:75706, Dec  7 2009, 18:43:55)
[GCC 4.4.1]
numpy 1.3.0
scipy 0.7.0
matplotlib 0.99.0
pyglet 1.1.2
PsychoPy 1.62.00
10-08-31 14:03 WARNING  Creating new monitor...

OpenGL info:
vendor: ATI Technologies Inc.
rendering engine: ATI Mobility Radeon HD 3400 Series
OpenGL version: 2.1.9016
(Selected) Extensions:
        True GL_ARB_multitexture
        True GL_EXT_framebuffer_object
        True GL_ARB_fragment_program
        True GL_ARB_shader_objects
        True GL_ARB_vertex_shader
        True GL_ARB_texture_non_power_of_two
        True GL_ARB_texture_float
```

1.3. Running an experiment

To try an experiment follow these instructions:

- Choose an experiment.
  - You can read the description of the experiment either before or after running the experiment.
  - However, some descriptions will tell you some details that could influence how you behave in the experiment, thus, reading the description can alter your results. In these cases the description includes a warning, and it is better to read the rest of the description after running the experiment.
  - In the description you'll find which experiment control software you need, and approximately how long it will take you to to run the experiment.
- Download the experiment, open it in the experiment control software (PsychoPy or OpenSesame), and run the experiment.
  - You can find more help for running the experiment in a control software in the link above (in the installation part).
  - If you run a PsychoPy experiment, copy also the analyze_log.py file to the folder your experiment is. This file is needed for some experiments to give you a quick review of your results.

- After starting the experiment in PsychoPy, you can choose the language of the experiment, you can set the ID of the participant, and in some experiments you can set some additional parameters.
- Follow the instructions on the screen during the experiment.
- Check your results. You have several options to do that.
  - In some PsychoPy experiments you'll see some of your main results graphically.
    - You need the analyze_log.py file in the folder where your experiment .py file is, otherwise the results will not be displayed.
    - You can save those graphs if you want it.
  - After finishing the experiment you'll find a file usually named like particpant_ID_experiment_name.csv. This file includes all your trials, and you can open and process it in any spreadsheet software (e.g., Microsoft Excel, LibreOffice Calc, etc.)
  - In some cases you'll find a particpant_ID_experiment_name.csv_result.txt file, that might summarize your main results numerically (usually the same data you could see graphically formerly).
  - You can display the graphical results again if you run directly the analyze_log.py file from PsychoPy. In this case you have to type the parameters. If the parameters are given correctly, the program displays the results again. Or you can give new parameters to analyze the data in a different way.
  - If you rerun the experiment, (a) delete or (b) rename the previous .csv log file, or (c) give a different participant_ID at the beginning of the experiment. Otherwise the new results will be appended to the previous one in the log file, giving incorrect results in the analysis.

2. Contribute

- If you want to suggest any corrections in the description of the experiments, leave a comment in the documents. The comments will be public, and anyone can see them.
- If you have any further comments, suggestion, etc., contact Attila Krajcsi.
- If you want to create new demonstrations, use the following templates.

2.1. Template for the experiment description

Template for the experiment description [https://docs.google.com/document/d/1YTr4UE7oYouw9tzW13CCv9svsV-W0Mju-iJJqB-Enbw/edit]

2.2. Template for PsychoPy experiments

Template for PsychoPy experiments [https://sites.google.com/site/kognitivgyakorlatok/home/fejlesztoknek/psychopy_demo_template.py]

3. Experiments

3.1. Perception

Attentional Blink Paradigm

Created by Gábor Lengyel
Date of creation: 2013.06.10.
Experiment software: PsychoPy
Estimated running time: 10 minute
Reference for the original experiment: Raymond, J. E., Shapiro, K. L., and Arnell, K. M. (1992). Temporary suppression of visual processing in an RSVP task: An attentional blink? Journal of Experimental Psychology: Human Perception and Performance, 18, 849–860.

Theoretical background

Rapid serial visual presentation (RSVP) is a specific paradigm in which visual stimuli are presented in rapid succession in the same location of the display. Usually the stimuli are letters, digits, words or pictures and each of them is shown for 100 ms. In these RSVP paradigm the task of the participants is to identify one or more target stimuli from the shown sequence of the stimuli. In a single detection task the participant has to identify only one stimulus from the stream of the stimuli. For example, the participant's task is to name the letter that was white in the stream of black letters. In multiple-task RSVP the participant has to detect two or more stimuli from the stream of the stimuli For example, the participant identifies the white letter (as the first target) in the stream of back letters, then as a second task the participant have to detect a black X in the same stream (Raymond, Shapiro and Arnell, 1992)[1]. With multiple-task RSVP it was revealed that there is an impaired perception of the second target stimulus if it is presented 180 ms after the first stimulus and it lasts for approximately 500 ms (Zhang, Zhou, and Martens, 2011)[2]. First Broadbent and Broadbent (1987) found this phenomenon in a multiple-task RSVP and later Raymond and his colleagues (1992) named it attentional blink (AB) (Raymond et al., 1992).

Raymond and his colleagues (1992) established a model for the phenomenon. If we pay attention to an object in RSVP it causes a temporary suppression of visual processing. The identification of the first target stimulus interferes with a next non-target stimulus, then the second target cannot be processed due to this interference which lasts approximately 500 ms. AB emerges only when a new visual input appears before the perception process of the first target stimulus is complete. In such case the first target stimulus and the stimulus immediately after it will be processed together and leads to confusion if the features of the two stimuli are similar to each other. In order to avoid further confusion the visual attention shuts down for a period of time until the undergoing perception processes are complete. This results in the AB phenomenon (Raymond et al., 1992).

There are some alternative models for AB, which can be read in extended theoretical background section.

[1]Raymond, J. E., Shapiro, K. L., and Arnell, K. M. (1992). Temporary suppression of visual processing in an RSVP task: An attentional blink? Journal of Experimental Psychology. Human Perception and Performance, 18, 849–860.
[2]Zhang, D., Zhou, X., and Martens, S. (2011). Negative attentional set in the attentional blink: control is not lost. Attention, Perception, and Psychophysics, 73(8), 2489–2501.

Procedure

In this demo the classic experiment of the AB can be found. It is similar to the second experiment conducted by Raymond and his colleagues (1992). However we use less trial in order to shorten the running time of the demonstration.

In this experiment black colored letters are presented successively on the display rapidly. Each letter is shown for only 90 ms on the display. In the experimental condition the participant has two tasks: (i) to detect and name the white letter in the letter stream and (ii) to tell whether there was an X in the letter stream or not. In the control condition the participants are asked to ignore the white letter and they only have to decide whether they saw an X or not. See the letter stream in Figure 1.

In the demo script you can choose from two conditions: "experimental_condition" and "control_condition". In "experimental_condition" the participant has to detect two target stimuli, while in "control_condition" the participant has to identify only the second target.

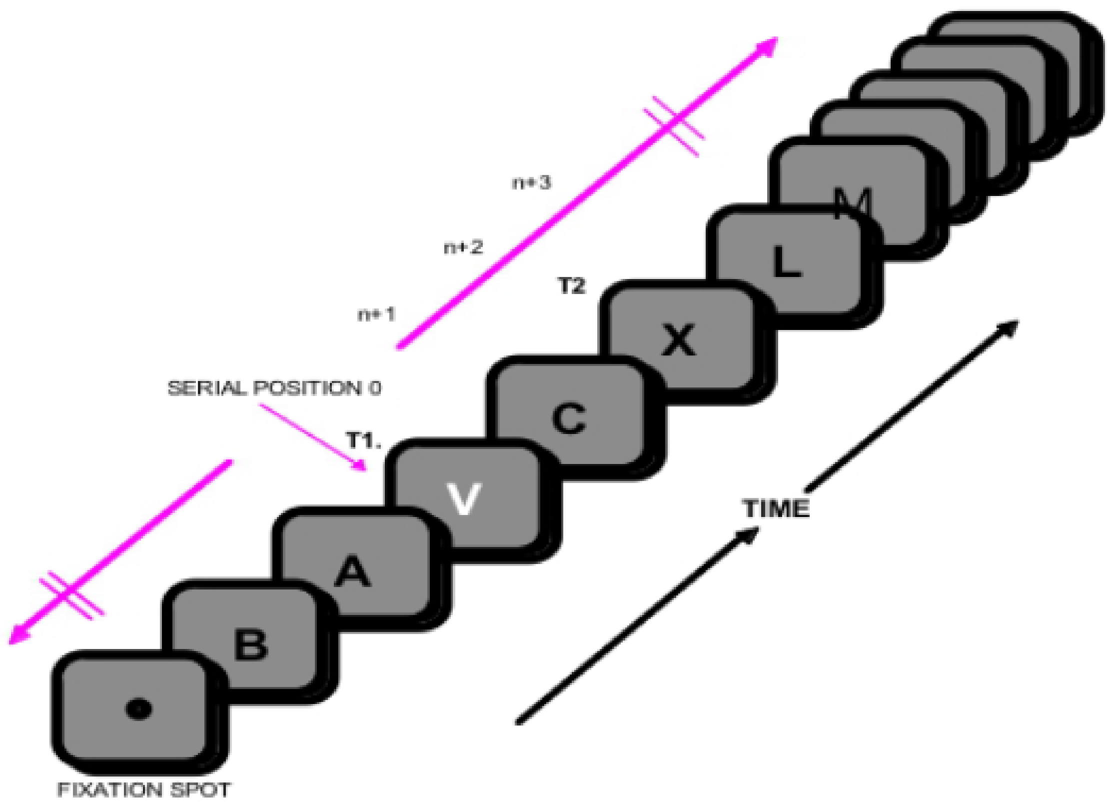


Figure 1.

Expected results

In the experimental condition of the experiment the percentages of the correct detection of the second target (X) diminishes below 60% if the second target appeared 180-450 ms after the first target (the white letter). Thus, the identification of second target is impaired if it is presented as the second, third, fourth and fifth stimulus after the first target. In the control condition the detection of the second target is always above 85% independently where it was shown in the letter stream. See the expected results in figure 2. The experimental condition is called dual-task because the participant has to detect two target stimuli, and the control condition is called single-task in Figure 2.

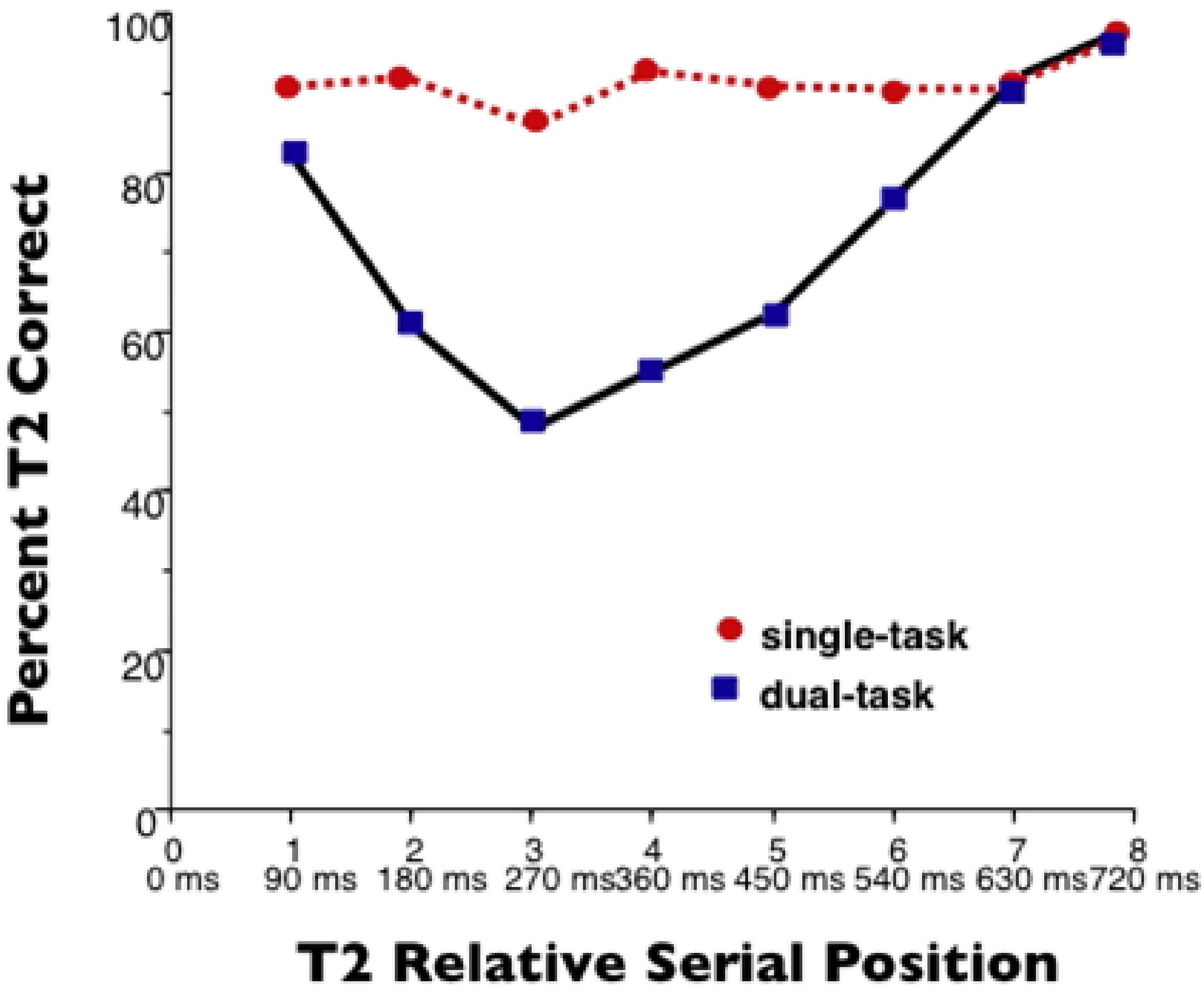


Figure 2.

Extended theoretical background

There are some alternative models so far explaining AB. The alternative models rely on additional features of AB. It was revealed that during the AB period the participant does commence the processing of the stimulus but the stimulus does not reach the level of consciousness. Shapiro and his colleagues (1997) conducted the same experiment as Raymond et al. (1992) in which there were three targets. They found that the undetected second targets produced priming effect on the third targets. Luck et al. (1996) investigated event related brain potential in AB paradigm. They measured visual perception (N1, P2) and semantic (N400) process related potentials during the AB (Shapiro, Arnell and Raymond, 1997)[3].

Chun and Potter (1995) suggest a two stage model for describing the AB. The first stage is a lower level unconscious processing, where the features and the meanings are registered. During the second stage of processing the stimulus is consolidated in short-term memory in order to reach consciousness. There is a limited capacity for consolidating stimuli with features and additional concepts. Thus, in the AB period the processing of the first target occupies the capacity for consolidation and the representation of the second target cannot be properly consolidated, therefore, the second target remains unconscious or becomes overwritten by other stimuli. The second stage can be considered as the working memory, and Vogel and his colleagues found in an event related potential paradigm that during the AB period there were no P3 waveform which is usually related to working memory processes (Shapiro et al., 1997).

In a study Olivers and his colleagues (2007)[4] proposed that the previously stated models could not explain entirely the AB. In their research they used target stimuli up to 4 in multiple-task RSVP paradigm. They found that the participants could detect all of the four targets if the targets appeared right after each other. There was no AB after the first target even if there was a stimulus immediately after it. According to their new model AB is due to an overzealous executive control system over the processing of the input stream. In such task attention is focused on differentiating between target and distractor stimuli. Thus the expected features of the targets are highlighted while the features of the distractors are ignored. The executive control system regulates the selection of the input (target from distractor stimuli) according to a criteria system. If the criteria are set too sturdily to detect all of the targets, then it is more likely to select distractors which are similar to the targets. If the criteria are set to avoid selecting distractors then more targets will be missed. In a multiple-task RSVP paradigm when the first target is identified the criteria of the executive control system shifts towards the identifying all of the targets strategy. Because the control system detected useful information (the target stimulus) from the input stream the system prepares itself and expects the next stimulus to be salient too, thus, the next stimulus will be selected. If it was the second target than the criteria of the executive control system remains. However, if it was a distractor stimulus the criteria of the executive control system shifts to the strategy of avoiding distractor stimuli from being selected. This is a compensation for selecting a distractor from the input and it is responsible for the AB phenomenon. Therefore AB can occur across the entire stream of the stimuli regardless of the temporal position of the targets (Olivers, Stigchel and Hulleman, 2007).

Recommended readings

Attentional blink on Wikipedia [http://en.wikipedia.org/wiki/Attentional_blink]
Attentional blink on scholarpedia [http://www.scholarpedia.org/article/Attentional_blink]
Video demonstration of the AB paradigm on youtube [http://www.youtube.com/watch?v=MH6ZSfhdIuM]
Demonstration of an AB paradigm [http://www.cs.kent.ac.uk/people/rpg/pc52/AB_Webscript/instr.html]

Eriksen flanker test

Created by Krisztina Peres
Date of creation: 2013.04.10.
Experiment software: PsychoPy

[3]Shapiro, K. L., and Arnell, K. M., Raymond, J. E., (1997). The attentional blink. Trends in Cognitive Science, Vo. 1, Number 8, 291–296.
[4]Olivers, C. N. L., Stigchel, S., and Hulleman, J. (2007). Spreading the sparing: against a limited-capacity account of the attentional blink. Psychological Research, 71(2), 126–139.

Estimated running time: 2-5 minute
Reference:
Eriksen, B.A., Eriksen, C.W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. Perception and Psychophysics, 16, 143-149.
Van Veen, V., Cohen, J. D., Botvinick, M. M., Stenger, V. A. and Carter, S. C. (2001). Anterior cingulate cortex, conflict monitoring, and levels of procession. NeuroImage, (14), 1302-1308.

Theoretical background

Eriksen flanker test is a method to measure visual attention. It belongs to conflict paradigms: in these tasks the stimuli activates conflicting responses (Styles, 2006)[5]. In the Eriksen paradigm a five letter set is shown, but the participant has to respond only to the middle letter. The response should depend on the letter presented in the middle position, e.g., if middle letter is "S" then participant should push the key "4"; if "H" then key "5". Conflict is caused by neighbour (flanker) letters, because they activate other response than the letter in the middle position (e.g. SSHSS). In the conflict cases the reaction time increases compared to conditions, where only one letter was shown, or where the flanker letters are identical with the middle letter (e.g. SSSSS).

Result of the paradigm is interpreted by continuous information process models, which means a stimulus can activate different responses at the same time in the brain. These responses can inhibit each other, as it happens in the Eriksen flanker test, where middle and flanker letters are in inhibitory relation. However, with the progress of processing the correct answer gets more activation, what finally generates the appropriate motor response. Although the interference can be detected with the appearance of incorrect responses, increased reaction times are more reliable signs of the inference (Sanders and Lamers, 2002)[6].

Procedure

In the original Eriksen and Eriksen (1974)[7] experiment, two independent variables were measured in six conditions (type of flanker letters, and space between them), which leads to high number of stimuli presentation. The present demonstration is based on a simpler version by van Veen, Cohen, Botvinick Stenger and Carter's (2001)[8], where only the type of the flanker letters were manipulated.

In the study participants had to respond to the middle letter of a five letter stimuli set: if "S" or "M" were in the middle, they had to push key "4"; if "P" or "H" were the middle letters, then key "5" should be used. On the left and right side there were two-two letters (e.g. PPHPP). Three conditions were used:

In the congruent condition (CO) middle and flanker letters were the same letters e.g. SSSSS.
In the stimulus-incongruent (SI) condition, while the middle and the flanker letters were different, both of them activated the same answer, e.g., SSMSS: for both "S" and "M" letters the key "4" should be pressed.
In the response-incongruent condition (RI) condition, the different flanker and target stimuli required different button presses., e.g., SSHSS, where for "S" right answer is key "4", for H right answer is key "5".

After the instruction, 96 trials were used in six blocks (in one block there were 16 stimuli: all of the 16 combinations that is available from the four letters). In each block 50% of stimuli were from congruent

[5]Styles, E. (2006). The Psychology of Attention, 2.ed..New York, NY: Psychology Press.
[6]Sanders, A. F. and Lamers, J. M. (2002). The Eriksen flanker effect revisited. Acta Psychologica, (109), 41-56.
[7]Eriksen, B.A., Eriksen, C.W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. Perception and Psychophysics, 16, 143-149.
[8]Van Veen, V., Cohen, J. D., Botvinick, M. M., Stenger, V. A. and Carter, S. C. (2001). Anterior cingulate cortex, conflict monitoring, and levels of procession. NeuroImage, (14), 1302-1308.

condition (CO), 25-25% from the other two types of incongruent conditions (SI, RI). Stimuli were randomly presented. One letter set with a little arrow pointed to the middle letter, stayed for 300 ms. Then a fixation cross appeared until the participant gave a response. The interval between the response and the next stimulus was 11,700 ms. In the study response and reaction time were measured, and analysed. In the present demonstration 64 stimuli is presented.

Expected results

We expect faster responses in the congruent condition (CO) than in the different response incongruent condition (RI). We expect the reaction time of the stimulus incongruent (SI) condition to be between the reaction times of the CA and the RI conditions. These results can be seen in the study of van Veen, Cohen, Botvinick, Stenger and Carter (2001).

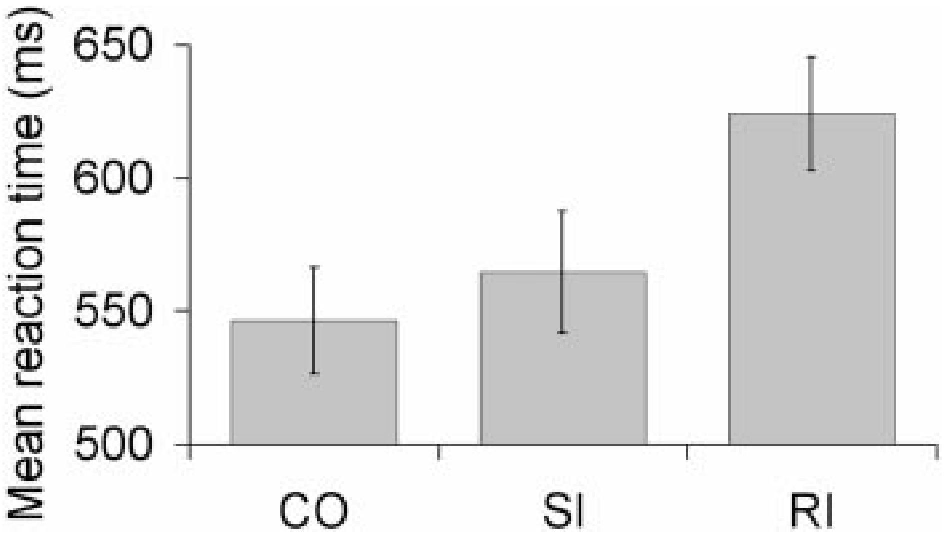


Figure 1. Mean reaction time for the middle letter by congruent flankers (CO); stimulus incongruent flankers (SI), and by response incongruent flankers (RI).

Recommended readings

Styles, E. (2006). The Psychology of Attention, 2.ed..New York, NY: Psychology Press.

3.2. Executive functions

Go/no go paradigm

Created by Krisztina Peres
Date of creation: 2013.06.19.
Experiment software: PsychoPy
Estimated running time: 2-5 minute
Reference for the original experiment: Miller, J., Schäffer, R., and Hackley, S. A. (1991). Effects of preliminary information in a Go versus No-go task. Acta psychologica, 76(3), 241–92. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/1927576

Theoretical background

The go/no-go paradigm is a selective reaction test, in which participants have to respond only to one of the two alternative stimuli (the go stimulus), while the participant shouldn't respond to the other stimulus (the no-go stimulus). Donders was the first to use this paradigm. He measured the speed of mental processes (Donders, 1969)[9]. According to his subtraction method, selective reaction time (deciding about response depending on the stimuli) takes longer than a simple reaction time, because besides perceptual analysis and response execution, there is a third stage in selective reaction task: response selection/decision stage (Miller, Schäffer, and Hackley, 1991)[10].

Nowadays go/no-go task is generally used to measure inhibition processes, because participants have to withhold response, when a no-go stimulus is presented, what requires inhibition control. The index of inhibitory control is the probability of executing a response on a no-go trial (ratio of false alarms) and reaction time difference between the no-go response and the to go response (Verbruggen and Logan, 2008)[11].

One explanation for the false alarm responses is that performance depends on the race between two competing processes: a go process and a stop process (horse-race model). The go process is triggered by the stimulus presentation; the stop process is activated by the identification of the no-go stimulus. The probability of responding on a no-go trial or a stop-signal trial depends on the relative finishing time of the go process and the stop process. When the stop process finishes before the go process, response inhibition is successful and no response is emitted; when the go process finishes before the stop process, response inhibition is unsuccessful and occurs an incorrect response (Logan and Cowan, 1984)[12].

In an alternative explanation, the executive act of control model by Logan and Cowan (1984) supposed that there are two interacting systems: an executive system that forms goals, intentions and generates commands to realize these intentions; and there is a subordinate system, that interprets the commands, and carries them out. In go/no-go paradigm when a no-go stimulus appears, the executive system inhibits the response by replacing the go goal with a stop goal (Logan and Cowan, 1984). With practice inhibition can become automatic because of the consistent stimulus-response mapping: go stimulus is always associated with responding, and no-go stimulus is always associated with stopping (Verbruggen and Logan, 2008).

Procedure

The present demonstration is based on the experiment of Miller, Schäffer, and Hackley (1991), but without preliminary cue stimuli. In the demonstration there are two types of stimuli: a green circle and a blue circle. Participants have to respond only to the green circle.

200 ms before the stimulus onset there is a fixation cross on the screen. Then, a green or blue circle appears, visible for 700 ms or until response. Interstimulus interval is 300 ms (+200 ms fixation cross).

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[9]Donders, F. C. (1969). On the speed of mental processes. Acta Psychologica, 30, 412–431.
[10]Miller, J., Schäffer, R., and Hackley, S. A. (1991). Effects of preliminary information in a Go versus No-go task. Acta psychologica, 76(3), 241–92.
[11]Verbruggen, F., and Logan, G. D. (2008). Automatic and controlled response inhibition: associative learning in the go/no-go and stop-signal paradigms. Journal of experimental psychology. General, 137(4), 649–72. doi:10.1037/a0013170
[12]Logan, G. D., and Cowan, W. B. (1984). On the ability to inhibit thought and action: A theory of an act of control. Psychological Review, 91(3), 295–327. doi:10.1037//0033-295X.91.3.295

Expected results

After the end of the demonstration participants can see their error rates for each condition. There are two types of error: false alarms and missing response. For the inhibition control false alarms are more informative than misses.

N-back task

Created by Krisztina Peres
Date of creation: 2013.06.26.
Experiment software: PsychoPy
Estimated running time: 2-5 minute
Reference for the original experiment: Cohen, J. D., Perlstein, W. M., Braver, T. S., Nystrom, L. E., Noll, D. C., Jonides, J., and Smith, E. E. (1997). Temporal dynamics of brain activation during a working memory task. Nature, 386(6625), 604–608. doi:10.1038/386604a0

Theoretical background

The n-back test is a working memory task. In the verbal version of the task letters are presented, and participants have to decide whether each stimulus in that sequence matches the one that appeared n items ago. In the 0-back condition, the target letter is any letter that was specified in the instructions. In the 1-back condition, the target is any stimulus identical to the immediately preceding stimulus. In the 2-back and 3-back conditions, the target is any stimulus identical to the stimulus presented two or three trials prior (Molteni et al., 2012)[13].

According to Baddeley's memory model, working memory contains two types of components: an executive control and specific buffers (e.g. visuo-spatial sketchpad, phonological loop) (Baddeley, 2002)[14]. In the n-back test both types of components are required, because participants have to store the previous stimuli in the buffers and have to update the actual stimuli to check by the executive control (Owen, McMillan, Laird, and Bullmore, 2005)[15]. In the verbal n-back task it is supposed that maintenance and updating of the information happens in the phonological loop.

Procedure

The present demonstration of the verbal n-back task is based on the experiment of Cohen et al. (1997)[16]. In the experiment, letters are presented and participant has to decide whether the current letter matches a letter presented formerly n stimuli ago.

In the demonstration there are three types of task. In 1-back task participants have to decide whether the current letter and the former one is the same or not. In 2-back and 3-back task instructions are the same, except that participants have to remember items 2 or 3 items before.

[13] Molteni, E., Contini, D., Caffini, M., Baselli, G., Spinelli, L., Cubeddu, R., Cerutti, S., et al. (2012). Load-dependent brain activation assessed by time-domain functional near-infrared spectroscopy during a working memory task with graded levels of difficulty. Journal of biomedical optics, 17(5), 056005. doi:10.1117/1.JBO.17.5.056005
[14] Baddeley, A. D. (2002). Is Working Memory Still Working? European Psychologist, 7(2), 85–97. doi:10.1027//1016-9040.7.2.85
[15] Owen, A. M., McMillan, K. M., Laird, A. R., and Bullmore, E. (2005). N-back working memory paradigm: a meta-analysis of normative functional neuroimaging studies. Human brain mapping, 25(1), 46–59. doi:10.1002/hbm.20131
[16] Cohen, J. D., Perlstein, W. M., Braver, T. S., Nystrom, L. E., Noll, D. C., Jonides, J., and Smith, E. E. (1997). Temporal dynamics of brain activation during a working memory task. Nature, 386(6625), 604–608. doi:10.1038/386604a0

Before presentation of the stimuli there is blank screen for 250 ms. Then, stimulus appears and remains for 1 second or until response. After that there is 300 ms delay.

Expected results

In the end of the task participants can see their performance on the three condition. Average error rates are displayed, and it is expected, that with greater memory load performance will be poorer.

Recommended readings

Baddeley, A. D. (1997). Human memory: Theory and Practice (Revised Edition). Hove: Psychology Press.

Simon task

Created by Krisztina Peres
Date of creation: 2013.05.30.
Experiment software: PsychoPy
Estimated running time: 2-5 minute
Reference for the original experiment: Simon, J. R., and Small, A. M., Jr. (1969). Processing auditory information: Interference from an irrelevant cue. Journal of Applied Psychology, 53, 433–435.
Reference for the basis of the demonstration
Bialystok, E., Craik, F. I. M., Klein, R., and Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: evidence from the Simon task. Psychology and aging, 19(2), 290–303. doi:10.1037/0882-7974.19.2.290
Hazeltine, E., Akçay, C., and Mordkoff, J. T. (2011). Keeping Simon simple: examining the relationship between sequential modulations and feature repetitions with two stimuli, two locations and two responses. Acta psychologica, 136(2), 245–52. doi:10.1016/j.actpsy.2010.07.011

Theoretical background

The Simon task is a choice reaction time task, which demonstrates the effect of irrelevant location information. In the original Simon task participant listened to two types of sound (low and high pitch) through the right or left speaker of a headphone. They had to respond to the pitch, but they had to ignore the location of the sound (e.g., they had to press the right response key for the low sound, and the left key for the high soun). The main finding was that participants could not ignore the location of the stimulus: they responded faster when the stimuli and the correct response key were on the same side (e.g., low sound to the right ear) (Simon and Small, 1969)[17]. The same effect was found with visually presented stimuli: for example, if a blue circle appeared on the left side of the screen, and participants had to respond with pressing a key located left, then reaction time was faster than reaction time for a blue circle on the right side (Lu and Proctor, 1995)[18].

The Simon task belongs to conflict paradigms such as Stroop test or Eriksen flanker test. In these tasks the stimulus can activate two different responses. According to the dimensional overlap model, conflict occurs when irrelevant stimulus dimension overlaps with the relevant stimulus dimension or when the irrelevant stimulus dimension overlaps with the response dimension, or both. For example, in the Stroop effect it is

[17]Simon, J. R., and Small, A. M., Jr. (1969). Processing auditory information: Interference from an irrelevant cue. Journal of Applied Psychology, 53, 433–435.
[18]Lu, C., and Proctor, R. W. (1995). The influence of irrelevant location information on performance: A review of the Simon and spatial Stroop effects. Psychonomic Bulletin and Review, 2(2), 174–207. doi:10.3758/BF03210959

the relevant and irrelevant stimulus dimensions (i.e., the meaning of the word and the color of the ink) that overlap. In the Simon task the conflict is due to the overlap between the irrelevant stimulus location and the response location (Kornblum, Hasbroucq and Osman, 1990)[19]. This means, that Simon task is probably the purest measurement of impact of irrelevant stimulus feature on response conflict (Hommel, 2011)[20].

The dual route model offers an alternative explanation for the underlying process of the effect. It assumes that information is processed by both intentionally controlled and automatic routes. Task instruction determines the intentionally controlled route (e.g., response location in Simon task), while the automatic route processes the task-irrelevant information (e.g. the location of the stimuli). If the two routes facilitate the same response, then the response is faster, otherwise the response is slower (Hommel, Proctor and Vu, 2004[21]; Verbruggen, Liefooghe, Notebaert, and Vandierendonck, 2005[22])

Procedure

The present demonstration is a visual version of the Simon task. It is based on the experiment of Bialystok, Craik, Klein and Viswanathan (2004)[23]. Stimuli were a blue and a red circles. Circles can appear either on the left side or on the right side of the screen. Participants had to press the left response button when blue circle appeared and they had to press the right response button when the red circle appeared. Thus, in that experiment the congruent condition included two types of trials: blue circle on the left side (left response) and red circle on the right side (right response button). The incongruent conditions included the other two possible combinations of color and side.

In a trial first a fixation cross appears for 200 ms followed by the first stimulus. A stimulus is visible for 1 second or until response. After the response there is 500 ms delay.

Expected results

It is expected that congruent trial reaction times are faster than the incongruent trials. In the end of the experiment error rates and median reaction times will be displayed for congruent and incongruent conditions.

Stop-signal paradigm

Created by Krisztina Peres
Date of creation: 2013.06.19.
Experiment software: PsychoPy
Estimated running time: 2-5 minutes
Reference for the original experiment: Verbruggen, F., Logan, G. D., and Stevens, M. a. (2008). STOP-IT: Windows executable software for the stop-signal paradigm. Behavior Research Methods, 40(2), 479–483. doi:10.3758/BRM.40.2.479

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[19]Kornblum, S., Hasbroucq, T., and Osman, A. (1990). Dimensional overlap: cognitive basis for stimulus-response compatibility--a model and taxonomy. Psychological review, 97(2), 253–70.
[20]Hommel, B. (2011). The Simon effect as tool and heuristic. Acta Psychologica, 136(2), 189–202.
[21]Hommel, B., Proctor, R. W., and Vu, K.-P. L. (2004). A feature-integration account of sequential effects in the Simon task. Psychological research, 68(1), 1–17.
[22]Verbruggen, F., Liefooghe, B., Notebaert, W., and Vandierendonck, A. (2005). Effects of stimulus-stimulus compatibility and stimulus-response compatibility on response inhibition. Acta psychologica, 120(3), 307–26. doi:10.1016/j.actpsy.2005.05.003
[23]Bialystok, E., Craik, F. I. M., Klein, R., and Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: evidence from the Simon task. Psychology and aging, 19(2), 290–303. doi:10.1037/0882-7974.19.2.290

Theoretical background

In the stop-signal paradigm participants perform a choice reaction task, for example, they press the left response key for the blue circle and press the right response key for the green circle. On a random selection of the trials (stop-signal trials), a stop signal is presented a short time after the onset of the stimulus, for example, a sound is played. This stop signal instructs the participant to withhold the response on those trials (Lappin and Eriksen, 1966[24]; Verbruggen and Logan, 2008[25]). Thus, while in a go-signal trial the participant responses to the stimuli, in the stop-signal trials they should not respond.

Stop signal paradigm is generally used to measure inhibition processes. Index of inhibitory control is the probability of responding on stop-signal trials (false alarms).

Stop signal delay varies in time, and the timing has great influence on response selection (Logan and Cowan, 1984): the later the stop signal appears, the more probable the participant responses to the trial.

One explanation for this finding is that performance depends on race between two competing processes: a go process and a stop process (horse-race model). The go process is triggered by the stimulus presentation; the stop process is activated by the presentation of the stop signal. The probability of responding on a no-go trial or a stop-signal trial depends on the relative finishing time of the go process and the stop process. When the stop process finishes before the go process, response inhibition is successful and no response is emitted; when the go process finishes before the stop process, response inhibition is unsuccessful and occurs an incorrect response.

In an alternative explanation, the executive act of control model by Logan and Cowan (1984) supposed that there are two interacting systems: an executive system that forms goals, intentions and generates commands to realize these intentions; and there is a subordinate system, that interprets the commands, and carries them out. In stop signal paradigm when a stop signal appears the executive system inhibits response by replacing the go goal, which is associated with responding to the go stimulus, with a stop goal, which is associated with withholding a response (Logan and Cowan, 1984).

Difference between the go/no-go paradigm and the stop-signal paradigm is in the response stimulus mapping. Responses to go or no-go stimuli remain the same all the time: stimuli and responses are mapped consistently. In the stop-signal paradigm stimuli and responses are not consistent, because response depends on the appearance of the stop signal, which is unpredictable (varied mapping). Stimulus-response mapping has great impact on automacy: for no-go trial inhibition can become automatic, but this is impossible by stop signal task, because of the unpredictable stimulus-response code (Verbruggen and Logan, 2008)

Procedure

he present demonstration is based on the study of Verbruggen, Logan, and Stevens (2008)[26]. In the experiment participants have to respond with two response keys when they see a rectangle or a circle. Sometimes a sound is displayed, to which participants are instructed not to respond.

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[24]Lappin, J. S., and Eriksen, C. W. (1966).Use of a delayed signal to stop a visual reaction-time response. Journal of Experimental Psychology, 72(6), 805–811.

[25]Verbruggen, F., and Logan, G. D. (2008). Automatic and controlled response inhibition: associative learning in the go/no-go and stop-signal paradigms. Journal of experimental psychology. General, 137(4), 649–72. doi:10.1037/a0013170

[26]Verbruggen, F., Logan, G. D., and Stevens, M. a. (2008). STOP-IT: Windows executable software for the stop-signal paradigm. Behavior Research Methods, 40(2), 479–483. doi:10.3758/BRM.40.2.479

In the experiment, timing of the stop signal stimuli is very important, because the later it comes the harder the inhibition of the reaction becomes. In the demonstration there are three conditions: in the first condition there isn't any stop signal, half of the stimuli belong to this condition. In the other two condition there is a stop signal 100 ms or 200 ms after the stimulus presentation. The timing of the stop signal can be set in the script. The interstimulus is interval is 800 ms.

Expected results

After the demonstration participants can see on a graph the mean value of errors in the three conditions. It is expected, that in stop-signal conditions there will be more error, than in the condition without stop signal.

Spatial Stroop test

Created by Krisztina Peres
Date of creation: 2013.06.18.
Experiment software: PsychoPy
Estimated running time: 2-5 minute
Reference for the original experiment: Virzi, R. A, and Egeth, H. E. (1985). Toward a translational model of Stroop interference. Memory and cognition, 13(4), 304–19. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/4079747

Theoretical background

The spatial Stroop test is based on the same method as the classic word-color stroop task: relevant and irrelevant stimulus dimensions are very similar or identical, which could influence (facilitate / inhibit) responding in some conditions. In the spatial Stroop test, participants have to respond to the meaning of a spatial word, therefore the relevant dimension is spatial word (RIGHT or LEFT). The words can appear on the two side of the screen, thus, the irrelevant dimension is the location of the word (right or left side). Stroop effect emerges if word meaning is incongruent with location of the word (e.g. LEFT on the right side). In this cases reaction time is generally slower compared to conditions, when word meaning and location are congruent (e.g. word LEFT on the left side) (MacLeod, 1991[27]; Lu and Proctor, 1995[28]).

One explanation for the spatial Stroop effect is offered by Virzi and Egeth's (1985)[29] translation model. According to this theory, words and locations are assumed to be processed in separate systems (i.e., verbal and spatial system), which systems work with their own codes. These systems encode the relevant stimulus dimensions and select responses. When encoding and response selection are processed within the same system, no Stroop effect occurs. For example, spatial system can encode location information and it can generate manual response, too. However, if the encoding and the response selection belong to different systems, translation between the systems is required, e.g., in the spatial Stroop task the meaning of the word (encoding in the verbal system) should be translated to the spatial code (response selection in the spatial system). In the spatial Stroop test this translated code is assumed to interfere with the easily available but irrelevant location information, that is probably causes the Stroop effect (Virzi and Egeth, 1985; Luo and Proctor, 2013[30]).

[27]MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. Psychological bulletin, 109(2), 163–203.

[28]Lu, C., and Proctor, R. W. (1995). The influence of irrelevant location information on performance: A review of the Simon and spatial Stroop effects. Psychonomic Bulletin and Review, 2(2), 174–207. doi:10.3758/BF03210959

[29]Virzi, R. A, and Egeth, H. E. (1985). Toward a translational model of Stroop interference. Memory and cognition, 13(4), 304–19.

[30]Luo, C., and Proctor, R. W. (2013). Asymmetry of congruency effects in spatial Stroop tasks can be eliminated. Acta psychologica, 143(1), 7–13. doi:10.1016/j.actpsy.2013.01.016

According to Kornblum's dimensional overlap model, conflict occurs when irrelevant stimulus dimension (e.g. location of the word) overlaps with the relevant stimulus dimension (meaning of the word) or with the response dimension (location of the reponse button), or both (Kornblum and Lee, 1995)[31]. In spatial Stroop task the overlapped dimension is space: both the relevant spatial word stimuli and the irrelevant location information are connected to the spatial dimension.

Procedure

The present demonstration is based on the experiment of Virzi and Egeth (1985). In the experiment participants have to respond with a keypress, when they see the word LEFT or RIGHT, ignoring the location where words appear. For the word LEFT appropriate response is pressing 'Y' key, and for the word RIGHT correct response is pressing 'M' key.

There are congruent and incongruent conditions. In the congruent condition, location words fit to the side they appear, while in the incongruent condition, word meaning and its localization are in conflict. There are 20 stimuli in each condition.

In a trial first a fixation cross appears for 200 ms followed by the first stimulus. A stimulus is visible for 1 second or until response. After the response there is 500 ms delay.

Expected results

It is expected that congruent trial reaction times are faster than the incongruent trials. At the end of the experiment error rates and median reaction times will be displayed for congruent and incongruent conditions.

3.3. Memory

Deese - Roediger - McDermott Paradigm

Created by Krisztina Peres
Date of creation: 2013.05.22.
Experiment software: PsychoPy
Estimated running time: 5 minute
Reference for the original experiment:
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, 21(4), 803–814. doi:10.1037/0278-7393.21.4.803
Watson, J. M., Balota, D. A., and Roediger III, H. L. (2003). Creating false memories with hybrid lists of semantic and phonological associates: Over-additive false memories produced by converging associative networks. Journal of Memory and Language, 49(1), 95–118. doi:10.1016/S0749-596X(03)00019-6

Warning

Reading the description of the Deese - Roediger - McDermott paradigm (DRM) may influence completing of the task.

[31]Kornblum, S., and Lee, J. W. (1995). Stimulus-response compatibility with relevant and irrelevant stimulus dimensions that do and do not overlap with the response. Journal of experimental psychology. Human perception and performance, 21(4), 855–75.

Theoretical background

The Deese - Roediger - McDermott paradigm is a memory testing method: it demonstrates, that even in the laboratory it is possible to generate false memories (Pezdek and Lam, 2007)[32]. Participants in the task have to study lists of words, and after the presentation of each list the participants have to recall the words. A list contains 12-15 associations of a keyword, but the keyword itself is not presented. For example, the keyword is "sleep", and the words that will be presented are "bed", "snore", "nap", etc. Results show the usual primacy and recency effect (serial position effect), so participants recall first and last words better. More importantly, the unpresented keywords are recalled with the same frequency as the presented words in the middle of the list. Inclusion of the unpresented keyword is even stronger in recognition task: participants tend to claim, that they remember words, that actually were not presented (Roediger and McDermott, 1995, Pezdek and Lam, 2007[33]).

One explanation for the effect is that spreading activation in the semantic network might activate unpresented words. Because of the associations, the node of the keyword receives stimulation from the associated words, and finally it becomes activated. This theory assumes, that activation spreads automatically and unconsciously. An alternative hypothesis assumes, that confusion of source monitoring account for false memories: participants generate the keyword internally, because it is related the presented words, and later they cannot tell whether it was generated by themselves or they have seen it before, thus, they confuse the source of the memory (Roediger, McDermott and Robinson, 1998)[34].

Procedure

The present demonstration is based on the original DRM experiment (Roediger and McDermott, 1995) with some modifications presented in a recent study (Watson, Balota, and Roediger III, 2003)[35]. Participants had to listen to these lists, and after each list they had to write as many words as they could remember. After listening all lists experiment continued with a recognition task presented in blocks (one block for each list). A recognition block contained two studied word, two unrelated item, two weakly related item, and the key word. In the demonstration the recognition part of the task is not present.

Stimuli and presentation procedure are from the recent version of the DRM paradigm (Watson, Balota, and Roediger III, 2003). In the demonstration there are six association lists (15 words in each list) presented, and after each list participants have to recall as many words as they can remember.

Words are presented visually and participants have to type in their responses. Words remain on the screen for 1500 ms, and after 250 ms delay the next word appears. After the end of the list presentation the participants have 90 seconds for recalling and typing the words. This procedure is repeated 6 times for the six lists of words.

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[32] Pezdek, K., and Lam, S. (2007). What research paradigms have cognitive psychologists used to study "false memory", and what are the implications of these choices? Consciousness and cognition, 16(1), 2–17. doi:10.1016/j.concog.2005.06.006

[33] 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, 21(4), 803–814. doi:10.1037/0278-7393.21.4.803 (http://psych.wustl.edu/memory/research/)

[34] Roediger, H. L., McDermott, K. B., and Robinson, K. J. (1998). The role of associative processes in producing false remembering. In M. A. Conway, S. Gathercole, and C. Cornoldi (Eds.), Theories of memory II (pp. 187–245). Hove, Sussex: Psychological Press.

[35] Watson, J. M., Balota, D. A., and Roediger III, H. L. (2003). Creating false memories with hybrid lists of semantic and phonological associates: Over-additive false memories produced by converging associative networks. Journal of Memory and Language, 49(1), 95–118. doi:10.1016/S0749-596X(03)00019-6

Expected results

In the task it is expected that the result will show serial position effect, and more importantly, the not presented keywords would appear with a frequency of the middle words in the list (Roediger and McDermott, 1995).

Recommended readings

Gallo, D. A. (2006). Associative Illusions of Memory. New York: Psychology Press.

Corsi-test

Created by Krisztina Peres
Date of creation: 2013.06.28.
Experiment software: PsychoPy
Estimated running time: 2-5 minute
Reference for the original experiment: Vandierendonck, A., Kemps, E., Fastame, M. C., and Szmalec, A. (2004). Working memory components of the Corsi blocks task. British journal of psychology (London, England: 1953), 95(Pt 1), 57–79. doi:10.1348/000712604322779460

Theoretical background

The Corsi block test assesses the capacity of the visual-spatial sketchpad within the working memory. The screen shows nine irregularly placed blocks. At the beginning of the experiment, a sequence is played: the blocks of that sequence are lit up one by one. The participant is required to reproduce the order of those block by pointing to the blocks in the correct order. When participants reproduced sequence correctly, the sequence length increased with one block on the next trial. When they failed to reproduce the sequence, the sequence length decreased with one block. The score is the maximum reproduced sequence-length.

According to Baddeley's memory model, working memory contains two types of components: an executive control and specific buffers (e.g. visuo-spatial sketchpad, phonological loop) (Baddeley, 2002)[36]. The Corsi test supposed to challenge the visuo-spatial sketchpad, because this type of buffer is responsible for temporarily maintaining and manipulating visuospatial information. Results of Corsi test is supposed to give information about one's visual span (Baddeley, 2002).

Procedure

The present demonstration of the Corsi test is based on the experiment of Vandierendonck, Kemps, Fastame, and Szmalec (2004)[37]. In the experiment, a sequence is presented by lighting up the blocks one by one. Each block is lit up for 1 second, the inter-item interval is 500 ms. The first sequence consists of five blocks. When participants reproduce sequence correctly, by clicking the blocks in the correct order, the sequence length is increased with one block on the next trial. When they failed to reproduce the sequence, the sequence length is decreased with one block. The minimum sequence length is two blocks, the maximum is nine. Score of the experiment is the maximum sequence length, which a participant fulfilled correctly.

[36]Baddeley, A. D. (2002). Is Working Memory Still Working? European Psychologist, 7(2), 85–97. doi:10.1027//1016-9040.7.2.85

[37]Vandierendonck, A., Kemps, E., Fastame, M. C., and Szmalec, A. (2004). Working memory components of the Corsi blocks task. British journal of psychology (London, England: 1953), 95(Pt 1), 57–79. doi:10.1348/000712604322779460

Expected results

It is expected that with greater memory load (more block to remember) the performance will be poorer.

3.4. Psycholinguistics

Semantic priming

Created by Gábor Lengyel
Date of creation: 2012.11.30.
Experiment software: PsychoPy
Estimated running time: 5 minute
Reference for the original experiment: Ortells, J.J., Daza, M.T., and Fox, E. (2003). Semantic activation in the absence of perceptual awareness. Perception and Psychophysics, 65, 1307-1317.

Theoretical background

Types of priming

Priming can be defined as the facilitative effect of a previously presented stimulus (called the prime stimulus) on the latency and the accuracy of the processing of a latter stimulus (called the target stimulus) (Neely, 1977)[38]. There are two main types of priming according to the level of the process that the priming effect influences: perceptual and conceptual. In case of perceptual priming the facilitative effect of the preceding stimulus is based on perceptual features, thus visual processes are involved, while the conceptual priming depends on semantic relatedness. Thus a semantically similar prime helps persons respond faster and more accurate to the target stimulus (Knowlton and Greenberg, 2008)[39]. The semantic priming effect is undoubtedly demonstrates a top-down process (Balota et al., 2006)[40].

In the categorization task demonstration semantic priming effect appears when a response to the target stimulus is faster and more accurate when it was preceded by a semantically related (to the target) prime stimulus than when an unrelated prime stimulus appeared before the target stimulus (Ortells et al., 2006)[41].

The three most frequently used paradigms for measuring semantic priming are the lexical decision, the semantic categorization and the naming task. In the lexical decision task the participants have to classify the presented words as existing or non-existing words. In the semantic categorization task subjects tell which category does the word belong to. In the naming task the participant has to name the word that appeared on the display (Masson, 1995[42]; Ortells et al., 2006). In each task both the reaction time and the error rate are measured for

[38]Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited capacity attention. Journal of Experimental Psychology: General, 106, 226-254.
[39]Knowlton, B. J., Greenberg, D. L. (2008) Implicit learning and memory. Handbook of Clinical Neurology, Volume 88, Chapter 10, Pages 225-23.
[40]Balota, D.A., Yap, M.J., Cortese, M.J. (2006). Chapter 9 - Visual Word Recognition: The Journey from Features to Meaning (A Travel Update). Handbook of Psycholinguistics (Second Edition), Pages 285-375.
[41]Ortells, J. J., Vellido, C.,Daza, M. T., and Noguera, C. (2006). Semantic priming effects with and without perceptual awareness. Psicológica, 27, 225-242.
[42]Masson, M. E. J. (1995). A Distributed Memory Model of Semantic Priming. Journal of Experimental Psychology: Learning, Memory and Cognition, Vol. 21, No. 1, 3-23.

detecting the semantic priming effect. In this demonstration we use semantic categorization in order to generate semantic priming.

In an example of semantic priming effect in a lexical decision task subjects make faster decision about the word "DOG" when it was preceded by a related word like "CAT" comparing to unrelated prime word such as "PEN" (Balota, Yap and Cortese, 2006).

First Collins and Quillian (1970)[43] found priming like effect in a sentence verification task. Then Meyer and Schvaneveldt (1971)[44] demonstrated the semantic priming in a lexical decision paradigm (Ober and Shenaut, 2006)[45].

The experiment will demonstrate the semantic priming effect in a two-choice semantic categorization task. Semantic categorization task was used to elicit priming effect in several studies (e.g. Balota and Chumbley, 1984[46]; Forster, 2004[47]). In Ortells and his coworker' (2003)[48] paradigm two choice semantic categorization task was implemented, which is the simplest way to demonstrate the priming effect. However two choice semantic categorization task was also applied in other studies, they used it in a different way (e.g. Fazio, Sanbonmatsu, Powell and Kardes, 1986[49]; Greenwald, Draine and Abrams, 1996[50]). In those experiments the task was to decide whether the stimulus was pleasant or unpleasant (Fazio, Sanbonmatsu, Powell and Kardes, 1986; Greenwald, Draine and Abrams, 1996).

Models for semantic priming

There are several models explaining semantic priming effect. First the spreading-activation theory must be clarified, which is a semantic network model of lexical knowledge representation. According to the classic spreading activation theory, the knowledge is represented in a form of interconnected network of nodes which are storing individual concepts. If a node becomes active, it activates those nodes which are connected to it, and these nodes also spread the activation further to related nodes. It is called the automatic spreading activation. However the activation is getting weaker and finally it fades away. According to this theory, this is how we retrieve knowledge (Collins and Loftus, 1975)[51]. Based on this theory spreading activation among the nodes is the most salient explanation for semantic priming effect (Neely, 1977).

The compound cue theory is a completely different model. It states that the prime and the target stimuli with all other elements of the context become connected during the encoding of the memory of that situation. Just like

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[43]Collins, A. M., and Quillian, M. R. (1970). Facilitating retrieval from semantic memory: The effect of repeating part of an inference. In: A. F. Sanders (Ed.), Attention and performance III (pp. 304–314). Amsterdam: North-Holland Publishing Company.

[44]Meyer, D. E., an Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. Journal of Experimental Psychology, 90,227–234.

[45]Ober, B.A., and Shenaut, G.K. (2006). Chapter 11 - Semantic Memory. Handbook of Psycholinguistics (Second Edition), Pages 403-453.

[46]Balota, D. A., and Chumbley, J. I. (1984). Are lexical decisions a good measure of lexical access? The role of word frequency in the neglected decision stage. Journal of Experimental Psychology: Human Perception and Performance, 10(3), 340–357.

[47]Forster, K. I. (2004). Category size effects revisited: Frequency and masked priming effects in semantic categorization. Brain and Language, 90, 276–286.

[48]Ortells, J.J., Daza, M.T., and Fox, E. (2003). Semantic activation in the absence of perceptual awareness. Perception and Psychophysics, 65, 1307-1317.

[49]Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., and Kardes, F. R. (1986). On the automatic activation of attitudes. Journal of Personal social psychology, 50, 229.

[50]Greenwald, A. G., Draine, S. C., Abrams, R. L. (1996). Three Cognitive Markers of Unconscious Semantic Activation. Scinece, Vol. 273, p. 1699-1702.

[51]Collins, A.M., and Loftus, E. F. (1975). A Spreading-Activation Theory of Semantic Processing. Psychological Review, 82, 407-428.

when we see somebody speaking to us, the face and the voice of that person will be connected in the encoding of that experience. Thus the connection between the prime and the target stimulus creates retrieval cue to the memory which are called compound cues. The familiarity of a compound cue will be higher for related prime-target stimuli than for unrelated ones, thus related stimulus pair can be retrieved more rapidly and it influences the response to the target (see: Dosher and Rosedale, 1989[52]; McKoon and Ratcliff, 1992[53]).

There exists several connectionist models. According to these models a notion is represented by a node which has several connections to other nodes. The knowledge of something is coded by the actual connections and the weights of these connections of the nodes. The spreading activation is assumed by these models and the activation is modulated by the weights of the connections and the possible ways where the activation can flow. The semantic network of our knowledge can be modeled by determining the connection, the weights and the possible ways of the activation (see: Hopfield and Tank, 1986[54]; Masson, 1995).

Procedure

The experiment will demonstrate the semantic priming effect in a two-choice semantic categorization task. There are some alterations in the present paradigm compared to the original experiment. In the original article the goal was to measure the influence of the mask stimulus on the priming effect by altering the delay of the mask. A mask is a visually different stimulus that is used to cover or hide the prime stimulus. The awareness of the prime can be manipulated with the delay of the mask stimulus, which is usually presented before and/or after the prime.

In order to demonstrate the semantic priming effect we use only the immediate masking condition, the related and unrelated trials are 50-50%, and the number of the trials is less than the number that was used in Ortells et al.' (2003) experiment. The stimuli remained the same as in the original article.

The structure of the experiment

The participant has to make semantic categorization task. There are two categories: "animals", and "body parts" containing four-four concrete and familiar words. These words are the stimuli: the animals (COW, BULL, FROG,TOAD) the body parts (HAND, FINGER, FACE EYES).
The related stimuli are: COW-BULL;FROG-TOAD;HAND-FINGER;FACE-EYES word pairs and in the other order too (BULL-COW;TOAD-FROG; ETC...).
The unrelated stimuli are: COW-HAND;FROG-EYES;HAND-BULL;FACE-TOAD word pairs and in other combinations too (BULL-FINGER;TOAD-EYES; ETC...). More unrelated word pairs can be generated.
The mask stimulus is a random string of letters: MDGTKSN.
The participants have to decide whether the word which appears on the display is an animal or a body part. If an animal can be seen "r" key must be pushed as a response, and in case a body part "i" shall be pushed.

Expected results

The participants' responses are faster in the related than in the unrelated trials. Therefore the reaction time of the subjects decreases in the categorization task if the target word was preceded by a related word (e.g.

[52]Dosher, B. A., and Rosedale, G. (1989). Integrated retrieval cues as a mechanism for priming in retrieval from memory. Journal of Experimental Psychology: General, 118, 191-211.
[53]McKoon, G., and Ratcliff, R. (1992). Spreading activation versus compound cue accounts of priming: Mediated priming revisited. Journal of Experimental Psychology: Learning, Memory and Cognition, 18, 1155-1172.
[54]Hopfield, J.J., and Tank, D.W. (1986). Computing with neural circuits: A model. Science, 233, 625- 633.

FINGER - HAND). In this experiment the prime was immediately followed by a mask, therefore the priming effect will be generated by automatic processes (Pecher, et al., 2002[55]; Ortells et al., 2003, 2006). Based on the spreading-activation theory the semantic priming effect can be explained by the following: the subject unconsciously perceives the prime this activates that node which (according to the spreading activation) further activate (partially) the nodes that are connected to it and these nodes activates other nodes and so on. If we go further from the original node the activation of the nodes become less and less. Generally the related information are stored in such nodes that are connected to each other. Thus the related prime will partially activate the target, which because of the partial activation can be more easily activated completely (Collins and Loftus, 1975).

Additional theoretical background

Theoretical debates about semantic priming

The semantic priming effect is undoubtedly demonstrates a top-down process. However it is not clear whether the effect is caused by semantic or associative relationship of the prime target stimuli. In case of an associative relation the frequent prime-target co-occurrence is accountable for the priming effect. For example DOG and BALL might have an associative relation in those people' mind who often play ball with their dogs. It cannot be considered as a semantic relationship, however BALL and ROUND have a semantic relation in our mind. It seems there is no pure semantic priming, the effect is more associative, although the name of the phenomenon has not changed (Balota et al., 2006). Priming effect can occur even if the prime stimulus is no longer perceivable consciously (Balota et al., 2006).

The other problem with semantic priming arises from the question whether the effect is an automatic or a strategy based process. In general, semantic priming effect is contaminated with strategies used by the participants. Priming effect can occur even if the prime stimulus is no longer perceivable consciously (Balota et al., 2006). Therefore if the prime stimulus is masked (using stimulus before and/or after the prime in order to avoid conscious perception of the prime) then in most of the cases priming is an automatic process. In this case the prime stimulus is not perceived consciously, therefore the subject cannot use volitionally controlled strategy. Only the automatic semantic priming effect is explained by the spreading-activation theory. One of the strategy processes that we might use in priming is the expectancy based strategy. The participant can make expectancy about the target after the prime stimulus was perceived. Thus if the target matches the expectation the response will be faster than if the expectation which was generated by the prime differs from the target. An example for expectancy based strategy is when there are more unrelated than related prime-target stimulus pairs. In this case the participants will expect the other unrelated categorizes of words after the prime stimulus, hence a related prime will facilitate, while an unrelated will hinder the response (Pecher, Zeelenberg, Raaijmakers, 2002).

The mediated priming and the backward priming effect

There are two recently studied types of semantic priming effect: the mediated priming and the backward priming effect. This demonstration will not deal with those effects, but it is worth mentioning them, because it reveals information about the nature of the semantic priming. The mediated priming occurs when the prime stimulus and the target stimulus are directly not related to each other, but via a mediator they will be associated. The classic example here is the word pair of "LION" and "STRIPES", which are not related to each other but

[55]Pecher, D., Zeelenberg, R. and Raaijmakers, J.G.W. (2002). Associative priming in a masked perceptual identification task: Evidence for automatic processes. The quarterly Journal of Experimental Psychology, 55A (4), 1157–1173.

through the mediator "TIGER" they would be connected. The mediated priming effect is an automatic process (Pecher, et al., 2002). The backward priming effect is when the prime follows the target temporally semantic priming effect still can be detected. It means that while the information about the target stimulus is being processed, the precept of the prime can catch up to that process and affect the response (Balota et al., 2006).

Recommended readings

Priming_on Wikipedia [http://en.wikipedia.org/wiki/Priming_%28psychology%29]
Balota, D.A., Yap, M.J., Cortese, M.J. (2006). Chapter 9 - Visual Word Recognition: The Journey from Features to Meaning (A Travel Update). Handbook of Psycholinguistics (Second Edition), Pages 285-375.
Ober, B.A., and Shenaut, G.K. (2006). Chapter 11 - Semantic Memory. Handbook of Psycholinguistics (Second Edition), Pages 403-453.

3.5. Numerical cognition

Symbolic numerical distance effect

Created by Attila Krajcsi
Date of creation: 2013.06.25.
Experiment software: PsychoPy
Estimated running time: 2 minute
Reference for the original experiment: Moyer, R. S., and Landauer, T. K. (1967). Time required for Judgements of Numerical Inequality. Nature, 215(5109), 1519–1520. doi:10.1038/2151519a0

Theoretical background

When comparing two symbolic numbers (e.g. which one is larger: 3 vs 6) the participants are faster and make less error if the numerical distance between the two numbers is large.

This phenomenon was described originally by Moyer and Landauer in 1967[56]. They argued that the reaction time is proportional with the ratio of the two numbers. The ratio is critical here: it is a well-known signature of a noisy and continuous representation working according to Weber's law. According to Weber’s law two stimuli can be discriminated if the ratio of them is above a specific threshold value. This value can be specified for any continuous perceptual property. This is an imprecise representation, and in 1967 it was surprising to see that numbers are represented on a imprecise representation, like for example the representation of loudness of a sound, or the representation of brightness.

Thus, the ratio-type distance effect is generally considered to be the sign of a continuous noisy representation of numbers, instead of precise and symbolic representation. This imprecise and continuous representation has many names in the literature: "mental number line", "analogue magnitude system" or "approximate number system" is the most frequently used labels.

Procedure

In the experiment the participant compares number-pairs.

[56]Moyer, R. S., and Landauer, T. K. (1967). Time required for Judgements of Numerical Inequality. Nature, 215(5109), 1519–1520. doi:10.1038/2151519a0

Expected results

The script computes the distance effect in the error rates and in the median reaction time of the correct responses. The independent variable is the numerical distance, the difference between the two numbers. For example, "distance 1" trials include number pairs like 2 vs 3, or 6 vs 5, while "distance 4" trials include 2 vs 6, or 7 vs 3, etc. In a typical run one should see decreasing error rates and response times as the distance increases.

Recommended readings

Dehaene, S. (1997). The number sense: How the mind creates mathematics. New York: Oxford University Press.
Relevant chapters of Stanislas Dehaene's book give an easily understandable summary of the most important phenomena related to the numerical distance effect, and why it had a major influence on the numerical cognition in the recent years.
Weber-Fechner law (n.d.) in Wikipedia. Retreived June 25, 2013 from http://en.wikipedia.org/wiki/Weber%E2%80%93Fechner_law (More information about the Weber's law.)
Approximate number system (n.d.) in Wikipedia. Retreived June 25, 2013 from http://en.wikipedia.org/wiki/Approximate_number_system (More information about the continuous noisy representation, the supposed source of the numerical distance effect.)

Subitizing

Created by Attila Krajcsi
Date of creation: 2013.06.25.
Experiment software: PsychoPy
Estimated running time: 6 minute for both condition
Reference for the original experiment: Kaufman, E. L., Lord, M. W., Reese, T. W., and Volkmann, J. (1949). The discrimination of visual number. American Journal of Psychology, 62(4), 498–525.

Theoretical background

In an object enumeration task one has to specify the quantity of objects. The reader might say, well, this is counting, and you shouldn't make it too difficult to read the text. Actually, experimental psychology identified several types of object enumeration, thus, the unusual language is intentional here.

In some tasks one would not want to enumerate the objects precisely, and this enumeration is called *estimation*. In estimation, the processing time is independent of the size of the array. In precise enumeration two types of processes were identified. Typically, up to four objects the enumeration is fast, and seems almost parallel (the processing time hardly depends on the number of objects). This fast and precise enumeration is called *subitizing*. Beyond four objects the enumeration is slower, and it strongly depends on the size of the array. This slower process is called *counting*.

One version of the present demonstration shows the subitizing and counting in precise enumeration.

There is a long debate about the source of subitizing. According to one influential idea the approximate number system can easily differentiate between numbers with large enough ratio. Because neighboring small numbers show large ratios between each other (e.g., 1:2 between one and two, or 3:4 between three and four), but neighboring large numbers show relatively small ratios (e.g., 7 vs 8, that is 7:8 ratio is too small for this system to detect), this approximate system can detect small values precisely, but cannot handle larger numbers (Dehaene and Cohen, 1994)[57]. This explanation predicts that the same subitizing-counting pattern should be seen if all arrays would be ten times larger, and the participants would know about it, i.e., 10, 20, 30, etc. items of arrays should be named. However, this is not the case, 10, 20, 30, etc. numbers do not show the subitizing pattern, thus, the approximate number system explanation was wrong (Revkin, Piazza, Izard, Cohen, and Dehaene, 2008)[58].

Another explanation suggests that there are visual indexes that can follow maximum 4 objects in the visual field, and subitizing is fast, because the applied indexes can be enumerated quickly, while counting requires attentional shift, making it a much slower process (Trick and Pylyshyn, 1993)[59].

A third explanation suggested that subitizing is simply a pattern recognition: while we recognize triangles and squares easily and enumerate small arrays quickly, we usually do not recognize 6 dots as a clear form or shape, thus we have to use a slower serial counting procedure (Mandler and Shebo, 1982)[60].

Enumeration of canonical (symmetrical and/or well-known) arrays is critical in contrasting the visual index explanation with the pattern recognition model. While pattern recognition model predicts that the pattern the items form in an array can influence the processing time, the visual index model predicts that the pattern of the items is not important. In the "canonical" version of this demonstration one can see that canonical patterns can be enumerated much faster, favoring the pattern recognition model over the visual index explanation (Krajcsi, Szabó and Mórocz, 2012[61]; Mandler and Shebo, 1982).

Procedure

In the experiment the participants first see an Arabic number, then an array of dots, and have to decide whether the items of the Arabic-array pair show the same values. In the original experiments verbal naming paradigm was used, but this Arabic-array matching task is easier to handle on a computer, still it shows the same effects as the verbal naming version (Krajcsi, Szabó and Mórocz, 2012; Mandler and Shebo, 1982).

At the beginning of the experiment the user can choose whether she want to use the classical version ("random") or the canonical patterns ("canonical").

Expected results

In the classical ("random") version one should see that the reaction time increases only slowly up to four (subitizing range), but starts to increase much faster beyond four (counting range).

In the "canonical" version the difference between the subitizing range and the counting range should be much smaller than in the classical version. If someone runs the canonical version several times, the difference can actually disappear.

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[57]Dehaene, S., and Cohen, L. (1994). Dissociable mechanisms of subitizing and counting: Neuropsychological evidence from simultagnosic patients. Journal of Experimental Psychology: Human Perception and Performance, 20, 958–975.

[58]Revkin, S. K., Piazza, M., Izard, V., Cohen, L., and Dehaene, S. (2008). Does subitizing reflect numerical estimation? Psychological Science, 19, 607–614.

[59]Trick, L. M., and Pylyshyn, Z. W. (1993). What enumeration studies can show us about spatial attention: Evidence for limited capacity preattentive processing. Journal of Experimental Psychology: Human Perception and Performance, 19, 331–351.

[60]Mandler, G., and Shebo, B. J. (1982). Subitizing: An analysis of its component processes. Journal of Experimental Psychology: General, 111(1), 1–22.

[61]Krajcsi, A., Szabó, E., and Mórocz, I. Á. (2013). Subitizing Is Sensitive to the Arrangement of Objects. Experimental Psychology, 1(-1), 1–8. doi:10.1027/1618-3169/a000191

Non-symbolic numerical distance effect

Created by Attila Krajcsi
Date of creation: 2013.06.25.
Experiment software: PsychoPy
Estimated running time: 5 minute

Theoretical background

When two array of items are compared approximately, the error rate increases if the numerical difference between the two arrays decreases. This phenomenon is called the numerical distance effect. Critically, the error rate is predicted by the ratio of the two values. The ratio is important here: it is a well-known signature of a noisy and continuous representation working according to Weber's law. According to Weber's law two stimuli can be discriminated if the ratio of them is above a specific threshold value. This value can be specified for any continuous perceptual property. Thus, numerosity of an array is stored in a noisy and continuous representation.

The present demonstration shows that it is the ratio of the arrays, and not the difference of the arrays that determine the error rate in an approximate array comparison task.

Procedure

In a trial the participant has to choose the larger of two arrays on the two sides of the screen.

In many dot comparison task the size of the items, the density of the items, the full luminance of an array, etc. are controlled. This control could ensure that the comparison is based on the numerical features of the set and not on the perceptual features of it. The control should be quite tricky, because we have less degree of freedom than the variables we want to control. It means that, for example, if you want to control the density of the items, and the number of the items is given, then you cannot control the whole area the array covers, because it is already determined by the number and the density. Still, there are many procedures how to control at least some of the parameters. See a list of references and a technical description of the control in Dehaene, Izard and Piazza (2005)[62].

However, in the present demonstration a more simple stimulus is used in which small black and white items are applied (e.g., Burr and Ross, 2008[63]; Dakin et al., 2011[64]).

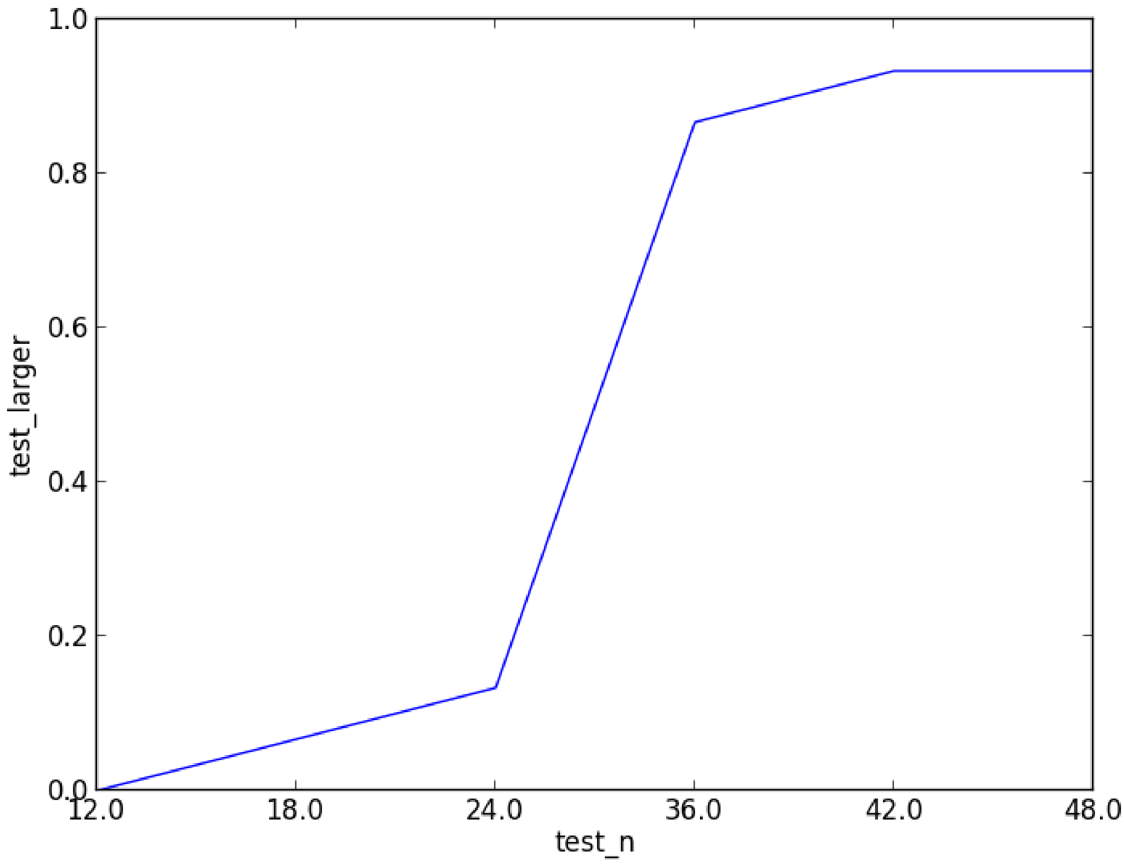
In the experiment one of the array is always a fixed value (reference number). The other array (test number) varies with specified ratios: -60%, -40%, -20%, +20%, +40% and +60%. When starting the demonstration one can choose whether the reference number should be 15 or 30. The test arrays will be generated according to the percentage values and the reference number, e.g., the -20% pair of the 15 reference value is 15-20%*15, which is 12.

Expected results

At the end of the demonstration, the ratio of the test number choice as the function of the test array will be displayed (see an example figure below). It means that if the test value is smaller than the reference number

[62]Dehaene, S., Izard, V., and Piazza, M. (2005). Control over non-numerical parameters in numerosity experiments.
[63]Burr, D., and Ross, J. (2008). A Visual Sense of Number. Current Biology, 18(6), 425–428. doi:10.1016/j.cub.2008.02.052
[64]Dakin, S. C., Tibber, M. S., Greenwood, J. A., Kingdom, F. A. A., and Morgan, M. J. (2011). A common visual metric for approximate number and density. Proceedings of the National Academy of Sciences, 108(49), 19552–19557. doi:10.1073/pnas.1113195108

(i.e., -60%, -40% and -20%), usually the reference is chosen, thus, the ratio will be low. However, if the test value is larger than the reference value (i.e., +20%, +40% and +60%), usually the test will be chosen, thus, the ratio will be high. This is the typical display form of psychophysical curves, and one should see a S shaped curve. Still, this graph could be converted to an error rate graph. When the ratio of test number choice is close to 0% on the left side or 100% on the right side, the error rate is low. Conversely, 100% on the left side and 0% on the right side means maximum error rate. When the ratio of the responses is around 50%, the choice is random.



Additionally, if the distance between the test and the reference value is small (e.g., -20% or +20%, the ratio will be closer to the 50%, because it is hard to decide which array is the larger when the difference is small. On the other hand, the ratios will be close to 0% or 100% when the ratio of the test and reference values is high (e.g., -60% or +60%). This is the distance effect.

Critically, running the demonstration with both the 15 and the 30 reference values, one should typically find the similar response ratios curve in the two versions, because the data are displayed as the ratio of the test and the reference arrays, which determines the ratio of the responses. This shows that the distance effect depends of the ratios of the arrays.

SNARC effect

Created by Attila Krajcsi
Date of creation: 2013.06.25.
Experiment software: PsychoPy

Estimated running time: 3 minute
Reference for the original experiment: Dehaene, S., Bossini, S., and Giraux, P. (1993). The mental representation of parity and mental number magnitude. Journal of Experimental Psychology: General, 122, 371–396.

Theoretical background

While deciding about the parity of a number (is the number even or odd) the responses with the left hand are relatively fast for the smaller numbers, and slower for the larger number, and conversely, the responses with the right hand are relatively fast for large numbers, and slower for the small numbers. This effect has a rather long name: the Spatial-Numerical Association of Response Code. The reason for this long name is this poem [http://www.gutenberg.org/ebooks/13].

It was argued that numbers are represented in an approximate number system, which system has a spatial property: it is aligned in space like a real number line, the small numbers located on the left side and the large numbers located in the right side. When one has to decide about the parity, this representation is automatically activated with the appropriate spatial location, and the activated location of the number interferes with the response side.

Procedure

In the experiment the participant sees single digits, and she has to decide whether that number is even or odd.

At the beginning of the experiment one can choose which response keys should be used for the even and odd responses. The experiment should be run with both response keys conditions to be able to calculate the SNARC effect.

Expected results

At the end of an experiment one can see the median reaction times for all numbers. But to calculate the SNARC effect, both response keys version should be run, and the median reaction times should be put for example in a spreadsheet software. The left hand responses should be subtracted from the right hand responses for all numbers (difference = right hand RT - left hand RT). Be aware that for example, for the even numbers the qp condition (q responses for the even numbers) includes the left hand response, and for the odd numbers the pq condition includes the left hand response. Generally, the smaller numbers should show positive differences (the left hand is faster, than the right hand, thus, a smaller number is subtracted from a larger number), and the larger numbers should show negative differences. However, the effect is very small, and the graph could be rather noisy.

Recommended readings

The Hunting of the SNARK (n.d.) in Wikipedia. Retreived June 25, 2013 from http://en.wikipedia.org/wiki/The_Hunting_of_the_Snark
Well, this is a psychological background in some unusual sense. Stanislas Dehaene named the SNARC effect as a tribute to Lewis Carroll.
See also another implementation of SNARC effect in Expyriment: https://code.google.com/p/expyriment/wiki/ExampleExperiments

Size congruity effect

Created by Attila Krajcsi
Date of creation: 2013.06.25.
Experiment software: PsychoPy
Estimated running time: 5 minutes
Reference for the original experiment: Henik, A., and Tzelgov, J. (1982). Is three greater than five: The relation between physical and semantic size in comparison tasks. Memory and Cognition, 10(4), 389–395. doi:10.3758/BF03202431

Theoretical background

In these tasks number pairs are displayed with various physical sizes. In one version of the task the participant should choose the numerically larger number of the pair, while in the other version participant decides about the physical size of the numbers. The numerical and the physical information could be congruent, neutral or incongruent: for example, in the numerical task, 3 **5**; 3 5; 3 **5**, respectively, and in the physical task, **3** 5; **3** 3; **5** 3, respectively.

The main result is that the irrelevant dimension influences the decision time: congruent trials are the fastest, neutral trials are slower, and the incongruent trials are the slowest. The effect works in both numerical and physical tasks, however, the reaction times are faster in the physical task, and the congruency effect is also smaller in the physical task than in the numerical task.

The results are explained in a similar way as in other congruency effects: both the relevant and the irrelevant properties are processed, and both pieces of information influence the response time.

Procedure

In the tasks the numbers should be compared. Depending on the version that was chosen at the beginning of the experiment, the comparison should be based either on the numerical value or on the physical size.

Expected results

In both versions one should see a congruent<neutral<incongruent order in the response times, however, in the physical task the effect is smaller than in the numerical task.

3.6. Want some more experiments?

Here is a list of other sites offering additional experiments:

- PsyToolkit [http://psytoolkit.gla.ac.uk/]
- Cambridge Brain Sciences [http://www.cambridgebrainsciences.com/]
- Cognitive fun [http://cognitivefun.net/]
- PsychMate [http://www.pstnet.com/software.cfm?ID=54]
- Lumosity [http://www.lumosity.com/] (commercial training program)
- Presentation demos [http://www.neurobs.com/menu_presentation/menu_teaching/exp_pack?pack_id=1] (requires Presentation licence)
- Paradigmas in Inquisit [http://www.millisecond.com/download/library/] (requires Inquisit licence)

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.