Experimental design for a mouse-tracking experiment

A replication study: Graded motor responses in the time course of categorizing atypical exemplars

Background

The structure of mental categories and cognitive processes of categorization has long been a field of intense study. In the past decades more refined theories of fuzzy categories and their interrelationship were developed. These oppose classical set theoretic accounts of categorization. Studies investigating typicality have immensely facilitated this transition and typicality emerged as one of the most thoroughly studied aspects of categories and concepts. Besides from exploring the static structure of categories through typicality judgements, one can also try to examine the decision process involved. This study attempts to investigate the effects of typicality on the time course of categorization using a mouse-tracking experiment. Spivey et al. (2006) already demonstrated that mouse-tracking provides a valid method in order to explore the continuous temporal dynamics of cognitive processes in typicality judgment tasks.
Typical mouse-tracking experiments require the participant to decide between two choices in the form of buttons on a computer screen while their cursor movements are continuously tracked. The screen setup adopted for each trial in our experiment can be seen below.

Fig. 1 *Screen presented to participants in the beginning of each trial. The red button in the bottom middle appears 2000ms after the two categories and serves to center the mouse cursor.*

Fig. 2 *After participants clicked on the centering button the typical/atypical exemplar word appears in the bottom middle.*

Eagle

Hypotheses

Preceding work by Spivey et al. (2005) on spoken word recognition demonstrated attraction effects on mouse movement trajectories towards competing objects. We expect similar effects in this study. Thus we predict mouse movement trajectories to exhibit a stronger curvature towards the competing category when categorising atypical exemplars compared to when categorising typical exemplars. Consequently we anticipate to observe a stronger curvature towards the competing category when categorizing the typical animal exemplar word “tuna” compared to the atypical animal exemplar word “dolphin” given the two categories “mammal” and “fish” as options. Additionally, we extend the experiment with a supplementary trial block where participants have to categorize typical and atypical cities and capitals. Exemplar cities are selected based on their strong or weak typicality as capitals and non-capitals. Hence we expect to see similar effects on the curvature of mouse movement trajectories as predicted for the main trials. Hence we hold the following **research hypotheses**:

1. The area under the curve (AUC) is larger for atypical trials compared to typical trials.
2. The maximal absolute deviation (MAD) is larger for atypical trials compared to typical trials.
3. Mouse-tracking duration is longer for atypical trials compared to typical trials.
4. The likelihood of obtaining different cluster types depends on the experimental conditions.
5. The total categorisation response time is longer for atypical trials compared to typical trials.
6. The movement initiation latency is longer for atypical trials compared to typical trials.
7. The distance travelled in pixels is longer atypical trials compared to typical trials.

In the case of the additional trial block we hold the same 7 hypotheses as above.

Design

Materials. We employ 5 atypical and 13 typical animal word stimuli for the main trials, as well as 3 typical or atypical animals word stimuli for the practice trials. The stimuli for the practice trials are taken from the original paper, whereas we generated new stimuli for the main trials (see Table 1). Therefore, practice and main trials taken together sum up to 21 trials. The main trials can be divided up into control and experimental trials, displayed in a randomised order.

In control trials the animal exemplar words are typical category members (e.g. “cow” as a member of the category “mammal”) and category pairs presented always consist of the correct category and a competing category randomly selected from the remaining five categories (“reptile”, “amphibian”, “bird”, “insect”, “fish”). In contrast, in experimental trials animal exemplar words are atypical category members and always occur paired with the correct and the same competing category. For instance, a trial with the animal exemplar word “seal” will always contain the category pairing of “mammal” and “fish”.

For our additional trials 14 city word stimuli are used, 7 typical and 7 atypical. The city word stimuli were selected guided by our individual, intuitive judgements about how typical they are as capitals and non-capitals of a specific country. Typicality in this sense refers to the degree of global popularity and whether the cities are known as being the capital of their respective country. Because Berlin is a popular city and similarly well-known to be the capital of Germany, this represents a typical city word stimulus of the category “capital”. While “Barcelona” is immensely popular, but not the capital of Spain and therefore an atypical city word stimulus of the category “non-capital”. The complete roster of stimuli used in our experiment is provided in the table below.

Table 1. Typical and Atypical Animal and City Word Stimuli for each Trial Block. With Response Options Given to the Participants (in Parentheses).

	Atypical	*Typical*
Practice trials (3)	Bat (*mammal*; **bird**)	Lion (*mammal*) Rabbit (*mammal*)
Main trials (18)	Frog (*amphibian*; **reptile**) Dolphin (*mammal*; **fish**) Seal (*mammal*; **fish**) Salamander(*amphibian*; **reptile**) Sea horse (*fish*; **mammal**)	Dove (*bird*) Cow (*mammal*) Eagle (*bird*) Tuna (*fish*) Fly (*insect*) Kangaroo (*mammal*) Ant (*insect*) Guinea pig (*mammal*) Mosquito (*insect*) Zebra (*mammal*) Clownfish (*fish*) Elephant (*mammal*) Snake (*reptile*)

Additional trials (14)	Barcelona (*non-capital*; **capital**)	Berlin (*capital*; **non-capital**)
	Sydney (*non-capital*; **capital**)	London (*capital*; **non-capital**)
	Beijing (*capital*; **non-capital**)	Paris (*capital*; **non-capital**)
	Ottawa (*capital*; **non-capital**)	Rome (*capital*; **non-capital**)
	Rio de Janeiro (*non-capital*; **capital**)	Moscow (*capital*; **non-capital**)
	Saigon (*non-capital*; **capital**)	Salzburg (*non-capital*; **capital**)
	Dubrovnik (*non-capital*; **capital**)	Las Vegas (*non-capital*; **capital**)

Note - Correct categories are given in Italics. As competing category labels of main, typical trials are selected in a randomized manner - either reptile, amphibian, mammal, fish, bird or insect - only correct categories are explicitly stated here. For main, atypical trials each competing category is given in boldface. For all additional trials the same typography-category mapping is applied. Italics indicate correct and boldface competing categories.

Procedure.

The experiment consists of 6 parts:

(I) introduction & initial questionnaire
(II) instructions
(III) practice trials
(IV) main trails
(V) additional trials
(VI) post-experiment questionnaire

After a short welcome view, we appeal to the participants to restrain from conducting the experiment on devices, such as mobile phones and tablets, to use a mouse if possible and to put their current internet browser in full-screen mode during the experiment. In the next two views participants are asked whether they are left- or right-handed and whether they are using a mouse or touchpad. Then, in the last view before the practice trials, participants are shown detailed, written instructions specifically emphasizing to focus on the two categories in the beginning of each trial and aim for speed and accuracy. Within each of the following trial blocks the order of stimuli presented is randomized ad hoc for each participant.

During the practice trials participants are expected to familiarize themselves with the task. Consequently, participants are given feedback on the correctness of their choice here. Apart from this the setup is the exact same in each trial block. Participants are presented with two animal/city category names, randomly assigned to one of the upper corners of the screen. A red button appears after a 2,000 msec pause in the bottom of the screen. Participants are instructed to click there and then wait for a target word to appear in its place, next to click on the upper right or left category that is appropriate for the target word in question. The practice phase includes 3 practice trials followed by the 19 main trials and the last trial block consisting of the 14 city exemplar words. As stated before, all trials are presented in random order.

Finally, after concluding the additional trials participants are asked to fill out a post-experiment survey including socio-demographic information and general feedback.

References

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