

## Negation and its associations in the non-linguistic domain

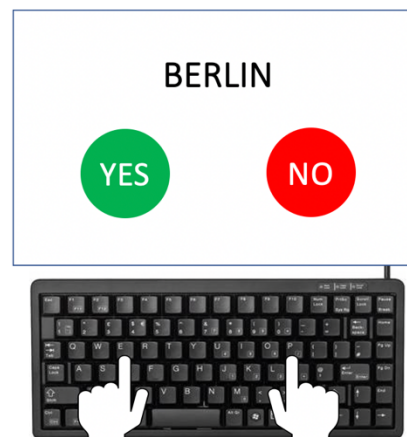
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### *Introduction*

Negation is typically viewed as a core linguistic process that takes up cognitive resources and under certain circumstances requires additional processing time compared to linguistic material without negation (Dudschig & Kaup, 2018; Deutsch, Gawronski, & Strack, 2006). Interestingly, negation is not limited to the linguistic domain. Rather negation behavior can also be observed in non-linguistic domains where it seems to be used rather naturally and automatically. For example people can express negation via specific facial expressions – the so-called not-face (Benitez-Quiroz, Wilbur, & Martinez, 2016), by walking away or pushing something away (Brouillet, Heurley, Martin & Brouillet, 2010), by specific gestures – such as putting the thumb down or crossing the arms in front of the chest, or negation can be expressed by means of non-linguistic symbols such as via crossing something out (Dudschig & Kaup, 2020; Dudschig & Kaup, in revision). In the current series of experiments we investigated whether linguistic negation is associated with specific non-linguistic features such as colours (e.g. red/black), shapes (e.g. spikey/edgy), or faces (e.g. unhappy face). We investigated this question from two different perspectives. First, we investigated whether the time required for answering simple “yes” vs. “no” questions can be influenced by the respective non-linguistic features in the response keys. Second, we investigated whether negated sentences are processed faster if they are preceded by the respective non-linguistic features.

### *Experiments*

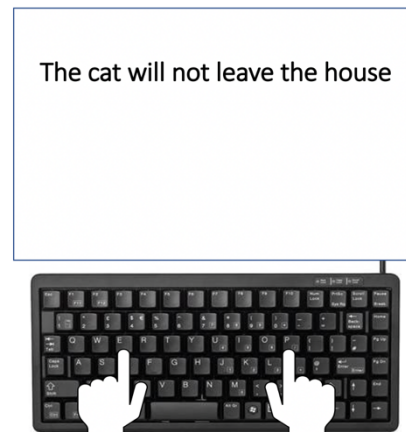
We report the results of six experiments. In Experiment 1-5, participants responded to a lexical decision task. More specifically, in each trial, participants were presented with a word or a non-word on the screen and indicated via a button press on a standard keyboard whether the presented stimulus was a word or not (see Figure 1). The response buttons were displayed on the screen whereby the location of the “yes” and “no” buttons (left vs. right) varied randomly in each trial. We also the background of the displayed “yes” and “no” buttons on the screen varied randomly. Across the experiments there was one face condition (smiley vs. frown), two shape conditions (smooth vs. spikey and round vs. square) and two colour conditions (green vs. red and white vs. black). As dependent variable we analyzed the time participants required for the lexical decision. We hypothesized that a negative response (pressing the “no” button) would be facilitated by certain non-linguistic features of the response buttons (e.g., frown, spikey, red) whereas an affirmative response (pressing the “yes” button) would be facilitated by a different set of non-linguistic features (e.g., happy, round, green). All experiments were pre-registered with the planned sample size of 50 participants and were run online. Today (25<sup>th</sup> September, 2020) each experiment has approximately 30 participants tested. The preliminary results show an effect of certain non-linguistic features on the lexical decision



*Figure 1.* Display of Experiment 1-5.

times, in particular with respect to the facial expressions, the red vs. green and the spikey vs. round contrast. In summary, these results show that there are specific non-linguistic features that are associated with an affirmative or negative response and therefore facilitate the response process if presented in a compatible manner.

In the final experiment we investigated whether these non-linguistic features also speed up reading times in a task that requires processing affirmative and negated sentences. Participants read neutral affirmative (e.g. *The cat will now leave the house*) and negated (e.g. *The cat will not leave the house*) sentences whereby each sentence was preceded by a picture that either displayed a type of non-linguistic affirmation (yes-face, approach gesture, thumbs up) or a type of non-linguistic negation (not-face, avoidance gesture, thumbs down). Intermixed were non-sensible sentences. Participants pressed a left or right key for the sensible vs. non-sensible decision (counterbalanced between participants). As dependent variable we analyzed the reading times of the sensible sentences. The experiment was pre-registered with a sample size of 80 participants which all have been collected. The results showed that sentence reading times are indeed influenced by the preceding picture in the expected manner. Specifically, there was an interaction between sentence-type (affirmative vs. negated) and picture-type (yes vs. no picture).



**Figure 2.** Display of Experiment 6.

### ***Discussion***

Overall, the results show that linguistic negation is associated with specific types of non-linguistic features (e.g. colour, spikiness, not-face). When these features are present in the response buttons of a simple lexical decision task, response times are sped up or slowed down in compatible vs incompatible conditions. Also reading times for negated and affirmative sentences can be influenced by preceding stimuli with these non-linguistic features. The current experiments used a rather wide variety of non-linguistic features and two types of linguistic negation (no-answers and sentential negation). Future studies should aim at investigating whether specific types of negation in the linguistic domain (e.g. denial, etc.) might be specifically associated with specific types of non-linguistic features (e.g. more symbolic gesture-like displays in contrast to rather low-level facial expressions).

### ***Literature***

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