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ANDREEVA GALINA ALEKSANDROVNA

EMBODIED MECHANISMS UNDERLYING THE PRODUCTION AND PROCESSING OF LINGUISTIC NEGATION

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Abstract

of the dissertation for the degree of candidate of psychological sciences

Scientific adviser:
doctor of psychological, associate professor
Ulybina Elena Viktorovna

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Abstract

of the dissertation submitted for the degree of candidate of psychological sciences by Andreeva Galina Aleksandrovna "Embodied mechanisms underlying the production and processing of linguistic negation"

The dissertation research is devoted to investigating the psychological mechanisms underlying the use and processing of linguistic negation. The study focuses on the relationship between negation, negative emotions, and sensorimotor responses, as well as on the question of whether linguistic negation can be regarded as a symbolic form of rejection behavior.

Negation is one of the universal linguistic categories represented in all languages of the world. It has been studied in philosophy, logic, linguistics, psychology, and neuroscience (Horn, 1989; Zhelesko & Rogovin, 1985). At the same time, the psychological mechanisms underlying the functioning of negation have been investigated far less comprehensively than its logical and linguistic characteristics. Cognitive psychology has primarily focused on the differences between the processing of negative and affirmative statements, particularly in terms of processing speed.

Within this line of research, the view has emerged that the processing of negation involves additional cognitive operations. According to the two-step theory, when a negative statement is perceived, the meaning of the negated word is initially activated and subsequently inhibited or cancelled (Kaup et al., 2007). Findings from behavioral and neurophysiological studies also indicate an association between negation and processes of cognitive control and inhibition (de Vega et al., 2016; Liu et al., 2020; Zuanazzi et al., 2022).

The inhibitory effect of linguistic negation manifests itself at different levels of processing. Behavioral studies demonstrate inhibition of motor responses during the processing of negative statements (Aravena et al., 2012; Zuanazzi et al., 2022). Experiments employing the Stop-Signal and Go/NoGo paradigms have revealed an interaction between negation processing and inhibitory control mechanisms at the

neural level (Beltrán et al., 2018; Montalti et al., 2023; de Vega et al., 2016; Liu et al., 2020).

Thus, one of the most robust findings in research on negation is its inhibitory effect. Negation is regarded as an operation associated with the inhibition of meaning. However, explaining the psychological mechanisms of negation only in terms of cognitive inhibition leaves a number of questions unanswered.

First of all, negation has pragmatic and emotional specificity. In everyday communication, negative expressions are frequently used in situations involving disagreement, refusal, prohibition, contradiction, and criticism. Many of these situations are associated with negative emotional states and involve the expression of rejection of a particular object, event, or statement (Beloborodova, 2010; Ubushaeva, 2008).

Several studies also point to an association between negation and negative affect. A specific facial expression – the "Not Face" – has been identified as accompanying the production of negative responses. This expression is associated with the contraction of muscle groups involved in the expression of anger, disgust, and contempt (Benitez-Quiroz et al., 2016). Linguistic theories also allow for the possibility that negation originated from early preverbal forms of expressing disgust, resistance, and rejection (Jespersen, 1958). A recent study demonstrated an association between the response "no" and emotionally negative symbols (Dudschig et al., 2023).

Thus, the theoretical analysis reveals two relatively independent lines of research on linguistic negation. On the one hand, substantial evidence has accumulated regarding the relationship between negation and inhibition. According to the two-step theory, comprehension of a negative construction involves activation of the meaning of the negated word followed by its inhibition (Kaup et al., 2007). Neurophysiological evidence supports the association between negation processing and cognitive control and inhibition (de Vega et al., 2016; Liu et al., 2020). On the other hand, evidence suggests

a relationship between negative response and negative emotions (Benitez-Quiroz et al., 2016; Dudschig et al., 2023). However, these two lines of research have developed in parallel and remain largely unconnected. A related issue is the limited empirical verification of the emotionally negative effect of negation: whereas the inhibitory effect has received numerous reliable confirmations, the association with negative emotions has been demonstrated only in a small number of studies and primarily with respect to the negative response "no".

The central research problem of the dissertation is the gap between the inhibitory neurophysiological effect and the emotionally negative effect of negation.

To bridge this gap, the dissertation proposes the **concept of the rejection response.** This concept represents an attempt to integrate affective and motor aspects into a unified explanatory model.

The theoretical foundations of the concept include: (1) the theory of neural reuse (Anderson, 2010), according to which new cognitive functions are built upon pre-existing and evolutionarily older functions; (2) the thesis concerning the motivational nature of emotions (Arnold, 1960), according to which the emotional appraisal of a stimulus directly initiates a behavioral orientation toward approach or withdrawal; and (3) ideas from embodied cognition (Barsalou, 1999; Wilson, 2002), according to which abstract symbolic operations retain their connection with sensorimotor experience.

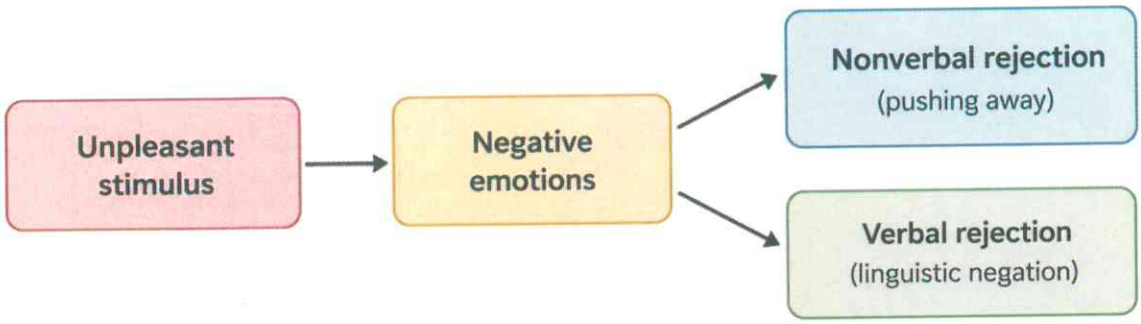
The rejection response is defined as a psychophysiological response to an unpleasant stimulus and has a two-component structure:

1. Affective component: the experience of a negative emotion that initiates behavior.

2. Behavioral component: a motor act aimed at reducing contact with an unpleasant stimulus through its removal or through distancing from it (pushing away, avoiding, stopping an action, looking away, moving away, etc.).

The central idea of the rejection-response concept is that linguistic negation constitutes a verbal and symbolic form of this earlier behavioral pattern. In situations in which physically removing a stimulus is impossible, inappropriate, or requires symbolic regulation, a verbal rejection response is activated in the form of negative constructions. Negative emotion is thus considered for the first time as the primary organizing factor ensuring continuity between nonverbal rejecting behavior and verbal negation (Figure 1).

Figure 1. Model of the Rejection Response



The concept of the rejection response made it possible to formulate the main hypothesis of the study and to test it empirically.

The main hypothesis is that the functioning of negation in speech, including both its processing and production, is associated with the experience of negative emotions and the manifestation of a motor pushing-away response.

To test the main hypothesis, three specific hypotheses were formulated. The first hypothesis assumes that describing emotionally negative stimuli is associated with a higher frequency of linguistic negation than describing emotionally positive stimuli. Confirmation of the first hypothesis will indicate that there is a valid connection not only between a negative response and negative emotions, but also between other negations

("not," "no," "without"). According to the second hypothesis, the experience of negative emotions activates pushing-away movements and increases the use of negation in speech. The third hypothesis assumes that the processing of negative phrases is associated with the experience of negative emotions and the manifestation of pushing-away movements of the hands.

The hypotheses were tested in three experimental studies. Quantitative content analysis of free oral speech was used to analyze speech output, with the number of negations being calculated using the Gottshalk–Gleser formula. Emotional states were assessed using direct rating scales. The motor component of the rejection response was investigated by recording the force of mechanical pressure. In the study of negative-phrase processing, a direct scale-based assessment of emotional responses, an indirect emotional assessment using the Color Test of Relations, and measurement of the distance by which participants moved cards containing verbal stimuli away from themselves were employed.

The first study was aimed at testing the existence of an emotionally negative effect in speech production. The main research question was whether the frequency of negation increases when participants describe emotionally negative stimuli (a sad picture and a frightening memory) compared with emotionally positive stimuli (a positive picture and a joyful memory).

The results showed that the type of stimulus itself (a picture or a memory) had no significant effect on the number of negative expressions used. At the same time, the emotional valence of the stimulus had a pronounced effect on the frequency of negation. When describing emotionally negative stimuli, participants used more negative constructions than when describing emotionally positive stimuli.

The findings of the first study confirmed the existence of an emotionally negative effect: the negative emotional valence of a stimulus is associated with an increased frequency of linguistic negation in speech production.

The second study examined the relationship between negative emotions and the verbal and motor components of the rejection response. Disgust, as an

emotional state associated with the rejection response, was compared with pleasure and a neutral emotional state.

The logic of the study was as follows: if linguistic negation represents a verbal form of rejection behavior, then a negative emotional state should be accompanied by the simultaneous activation of the rejection response at different levels. At the nonverbal level, this may manifest itself in increased pushing-away movements, whereas at the verbal level it may manifest itself in an increased frequency of negative constructions.

The results showed that the state of disgust was accompanied by an increase in the use of negation in speech. The mean negation coefficient was 1.96 in the disgust condition, 1.40 in the pleasure condition, and 1.49 in the neutral condition. At the same time, pushing-away movements were intensified in the state of disgust, as reflected in an increase in the force of mechanical pressure exerted by the hands on a special sensor.

The third study was designed to answer the question of whether the processing of negation activates components of the rejection response (negative emotions and pushing-away movements). The methodological challenge was to separate the emotional effect of negation itself from the emotional content of the words included in the phrase. To this end, emotionally neutral words were used to construct negative ("There is no letter") and affirmative ("This is a letter") phrases.

The use of emotionally neutral semantic content was of fundamental importance. If a phrase contains an emotionally negative word, a negative reaction may be caused by the semantic content of the word itself. In the case of a neutral word, a change in the emotional evaluation of the phrase following the addition of negation may be attributed to the effect of the negative operator.

The results showed that negative phrases elicit more negative emotional evaluations. According to the rating-scale assessment (1-7 scale), the mean emotional rating of negative phrases was 3.26, whereas the mean

rating of affirmative phrases was 4.45; the differences were statistically significant ($p < .001$). This indicates that adding negation to an emotionally neutral word significantly shifts the emotional evaluation of the phrase in a negative direction.

The results concerning the motor response also revealed significant differences. Participants placed cards containing negative phrases farther away from themselves (23.8 cm) than cards containing analogous affirmative phrases (14.9 cm). These findings indicate that negative phrases activate spatial distancing, which may be regarded as a motor manifestation of the rejection response.

Taken together, the findings of the three studies make it possible to consider the relationship between negation and the rejection response as a bidirectional process.

During speech production, negative emotions may activate the rejection response. At the nonverbal level, this response manifests itself in behavior aimed at distancing or pushing away. At the verbal level, it manifests itself in an increased frequency of negation.

During speech processing, a negative construction may activate components of the rejection response. This is reflected in the negative emotional evaluation of negative phrases and in the act of moving cards containing such phrases away from oneself.

Thus, the dissertation proposes a model according to which linguistic negation constitutes an abstract symbolic form of rejection behavior.

The scientific novelty of the study lies in clarifying the mechanisms underlying the functioning of linguistic negation. Whereas existing approaches have considered either an inhibitory response (Beltrán et al., 2018) or negative emotions (Benitez-Quiroz et al., 2016) as the primary basis of negation, the dissertation proposes a broader concept of the rejection response that makes it possible to integrate the inhibitory and emotional effects of negation. For the first time, empirical evidence is provided for the emotionally negative effect of linguistic negation: not only the response "no," but also other negative

constructions involving "not", "neither/nor", and "without" are associated with negative emotions.

Theoretically, the study is significant because it proposes a new way of understanding the sensorimotor response that may underlie abstract cognitive functions. Due to the difficulty of explaining abstract concepts within embodied theories, studies of sensorimotor simulation typically focus on words with clear motor or perceptual semantics, such as "open a drawer" or "clench a fist." Such actions are easy to imagine and reproduce and can be associated with corresponding brain regions. Negation, however, is an abstract linguistic unit that cannot be linked to one specific movement or sensation. Therefore, the explanation proposed through the rejection response is more complex and is based on a negative emotional attitude toward an object that initiates rejection behavior.

Overall, the proposed concept makes it possible to consider linguistic negation not only as a logical or cognitive operation, but also as an embodied symbolic form of a fundamental response to an undesirable stimulus. This interpretation expands existing conceptions of the psychological mechanisms underlying negation.

Future research may fruitfully focus on investigating negation as an indicator of an individual's emotional state. For example, the frequency of negation in speech may serve as a psycholinguistic marker of emotional states.