

ANNOTATION
on the PHD-thesis «Motor consequences of processing the lexical meaning of spatial idioms»

Nowdays, the embodied cognition approach continues to increase its' influence in cognitive science (Wilson, 2002; Günther et al., 2020). Regarding to the language processing there is a number of versions of the “embodied cognition” approach, in which sensorimotor processes are considered as components of the mechanism for processing linguistic stimuli: weak and strong embodiment approaches, secondary embodiment approach. The participation of sensorimotor processes is proved by the results of a number of studies (Wilson and Gibbs, 2007; Tettamanti et al., 2005; Desai et al., 2010).

At the same time, there is a contradiction in the results regarding the participation of sensorimotor processes in the language processing obtained within the framework of various versions of the “embodied cognition” approach on indicators reflecting the processing of linguistic information at the time of presentation of the linguistic stimuli themselves. On the one hand, it has been shown that real and imagined body movements associated with metaphors facilitate the understanding of the corresponding congruent phrases (Wilson and Gibbs, 2007). On the other hand, in some studies, a delay in the language processing was found under the condition of the same congruence of sensorimotor experience (Richardson et al., 2003; Postle et al., 2008), while the effect of facilitation is situational (Lebois et al., 2015; Thornton et al., 2013). There is also some data on the absence of participation of sensorimotor representations in the language processing (Galati et al., 2008). Thus, there is still no unequivocal answer regarding the involvement of sensorimotor processes in the language processing in approaches that focus on measuring the contribution of sensorimotor activity directly to the moment of processing language stimuli (Willems and Casasanto, 2011; Meteyard et al., 2012).

In our PHD-thesis we propose a new approach to the question of the participation of sensorimotor processes in the language processing through an indicator not

previously used for this purpose - motor consequences. Motor consequences are various involuntary movements (or changes in the characteristics of voluntary movements) observed in a person's actions after presenting him spatial idioms and expressed, for example, in facilitation of the motor response or in the eyes movements in a certain direction when performing a subsequent task.

Motor consequences are proposed to be used as a possible indicator of the participation of sensorimotor processes in the processing of spatial idioms. It is based on the already available experimental data that the activation of different metaphorical meanings of the same concept leads to differences in the functioning of cognitive processes (Tseng et al., 2005; Hauser, Schwarz, 2014; Lee, Schwarz, 2014; Keefer et al., 2014; Hendricks and Boroditsky, 2016; Elmore and Luna-Lucero, 2016; Thibodeau et al., 2017). We generalize this amount of research in terms of our proposed hypothesis of metaphorical relativity (hereinafter referred to as HyMR). HyMR interprets the motor consequences of the processing of spatial idioms as a possible indicator of the involvement of sensorimotor components in this process. HyMR is the assumption that there is a relationship between the cumulative representations of metaphorical expressions (including sensorimotor representations) and the functioning of cognitive processes that rely on or are associated with these representations. The available versions of the “embodied cognition” approach do not allow explaining the influence of metaphorical expressions on subsequent behavior, because the studies carried out within the existing framework test the participation of sensorimotor activity only while metaphor processing itself.

We use spatial idioms as the stimulus material, as the previous data on the absence of participation of the sensorimotor component in the language processing were obtained on the material of idioms (as a subcategory of metaphors) (Aziz-Zadeh et al., 2006; van Dam et al., 2014; Cacciari et al., 2011; Raposo et al., 2009). This makes idioms a very interesting stimulus material for the HyMR test.

Thus, we state the following problem in the PHD-thesis: do motor consequences arise while processing the lexical meaning of spatial idioms, semantically associated with the actualized representation of the processed language expressions.

We aim to solve the problem by using the theoretical base of the “embodied cognition” approach, developing a new experimental method based on spatial idioms, including a type of stimulus not previously used in research (language expressions with bidirectional spatial coordinates of the top and bottom), conducting behavioral experiments using an eye tracker that registers oculomotor reactions during the change blindness task, which was offered to the subjects for execution immediately after the presentation of spatial idiom.

The results obtained can be presented in the form of the following conclusions:

THEORETICAL:

1) Processing the lexical meaning of spatial idioms causes motor consequences revealing while solving specific cognitive tasks (performing a change blindness task): processing the meaning of an idiom activates a motor component semantically associated with the meaning being processed, which reveals itself in subsequent behavior.

2) Motor consequences are an indicator that the motor part of sensorimotor processes is involved in the language processing. It was shown on the speed features of the motor response (facilitation / inhibition), as well as the spatial and temporal specifics of eye movements after processing spatial idioms.

3) The hypothesis of metaphorical relativity is the assumption according to which there is a relationship between the emerging representations of metaphorical expressions (including sensorimotor representations) and the functioning of cognitive processes that rely on or are associated with these representations. Also, this hypothesis offers an explanation for the motor consequences that can be found when processing the meaning of spatial idioms.

4) The language processing on the example of spatial idioms can be explained in terms of a secondary embodiment or a weak embodiment. Idioms initially evoke amodal conceptual representation, then its characteristics are associated with relevant sensorimotor experience (secondary embodiment). It is also possible that the expression initially evokes a sensorimotor representation that mediates the emergence and amodal conceptual representation (weak embodiment). Our results are consistent

with both explanatory models. The results obtained do not correspond to the unembodied approach and the strong embodiment.

EXPERIMENTAL:

1) When processing the lexical meaning of spatial idioms, motor processes can perform a facilitating or inhibitory function, i.e. facilitate or inhibit the subsequent motor reaction, depending on the conditions of congruence or incongruence. Due to the results of first experiment, this is revealed as follows:

1.1. It was found that the congruence of the semantic and motor components of the processing of unidirectional spatial idioms reduces the reaction time when pressing the "up" arrow, if the expression for the subject is semantically associated with the "up", or on the "down" arrow if the expression is associated with the "down", and the incongruence of the semantic and motor components of the processing of unidirectional spatial idioms increases the reaction time when pressing the "up" arrow, if the expression for the subject is semantically associated with the "down", or - on the "down" arrow in if the expression is related to the "up";

1.2. It was found that the reaction time to bidirectional idiomatic expressions "up-down" (when performing the same task, see paragraph 1.1.) is significantly longer compared to the reaction time to "unidirectional" idioms.

2) When processing the lexical meaning of spatial idioms, motor processes have an orienting function: the direction of eye movements during the subsequent execution of the visual search task (on the basis of stimuli that cause the effect of “blindness to changes”) turns out to be associated with the semantic content of the processed idiom. Due to the results of second experiment, this is revealed as follows:

2.1. It was found that "unidirectional" idioms affect the subsequent execution of the task in the "blindness to change" paradigm so that the person spends more time during its execution, makes more fixations (only for the "down" idioms), and also makes a longer first fixation (only in the upper part of the screen and in the case of a real place of difference below the fixation cross), more fixations in the first visit and the first visit itself (for the both "up" and the "down" idioms), in a place congruent to the activated spatial locus;

2.2. It was found that for "up-down" idioms in the upper and lower parts of the screen there are no differences in any of the following metrics of the eye tracker: the relative indicator "dwell time" in the area of interest; the relative indicator of "fixation in the area of interest"; the duration of the first fixation; the number of all fixations on the first visit to each area of interest.

METHODOLOGICAL:

1) A new method based on spatial idioms was developed and tested in two experiments, including, among other things, a type of stimulus material not previously used in research, namely, language expressions with differently directed spatial coordinates of "up" and "down";

2) A new method was developed and tested for checking the motor consequences of the lexical meaning of spatial idioms: an eye-tracking method for registering motor activity parameters after language processing while solving an attention task (change blindness task).

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J.P. Migun /

