Is Good Always Right? The Flexibility of Space-Valence Body-Specific Associations

Violeta Valkova (valkova_violeta@yahoo.de)
Department of Cognitive Science and Psychology, New Bulgarian University
21 Montevideo Blvd., Sofia 1618, Bulgaria

Armina Janyan (ajanyan@cogs.nbu.bg)
Department of Cognitive Science and Psychology, New Bulgarian University
Research Center for Cognitive Science, New Bulgarian University
21 Montevideo Blvd., Sofia 1618, Bulgaria

Abstract

According to the body-specificity hypothesis (Casasanto, 2009) people who interact with the environment differently (e.g., right- and left-handers) associate positive concepts with the space around their dominant hand, and negative concepts with the space around their subordinate hand. Our exploratory study replicated and extended previous findings, establishing a relationship between handedness and mental representation of emotionally valenced abstract concepts. In a task required bimanual categorization of positive and negative nouns participants showed different RT-profiles depending on their handedness. Right-handers categorized positive words faster with their right hand than with the left and negative words faster with their left hand than with the right. Left-handers showed the opposite pattern, whereas ambidextrous showed no differences in the categorizing speed for positive and negative words. Most importantly, the study suggested that these associations were critically influenced by experienced motor fluency. After 12 minutes of hampered interaction with the environment right-handers changed their RT-profiles of associations between space and valence. The results suggest that at least some of our abstract representations are so sensitive to the experienced motor (dys)fluency that it can be manifested within 1 sec of word processing.

Keywords: body-specificity hypothesis; space-valence associatios; handedness; motor fluency; RT

Introduction

A growing body of empirical evidence opposes the idea that mental representations are just symbols on which computations are performed, emphasizing the important role of the interaction of our own body with the environment (Fischer & Coello, 2015). According to the body specificity hypothesis (Casasanto, 2009) the abstract concept of emotional *valence* is represented in terms of the concrete concept of the *space* around our bodies. In order to stress the importance of the peculiarities of the human bodies Casasanto (2009) focused on a comparison between left- and right-handed people who are supposed to interact differently with the environment. Using a task that required participants to distribute ‘good’ and ‘bad’ animals into two boxes on their left and right sides, the author demonstrated that right-handers tended to put more “good” animals in the right box and more “bad” animals in the left one, whereas left-handers did the opposite. As an explanation for the results Casasanto (2009) suggests that more fluent interaction with the space around the dominant hand causes people to implicitly associate their sensory-motor experience with positive emotions and the disfluent interaction with the space around their subordinate hand - with negative emotions. Evidence for the importance of the motor fluency came also from a study by Hayes et al. (2008). The authors asked people to move neutral objects - either fluently or non-fluently due to an obstacle. Afterwards participants preferred more the objects that have been moved fluently, emphasizing the positive affect as a consequence of the experienced motor fluency.

Empirical support for the space-valence body-specific associations was found both in different cultures (de la Fuente et al., 2015a; Zhao et al., 2016) and in early childhood (Casasanto & Henetz, 2012). Further support came outside the laboratory. It was observed that during public speech people used their dominant hand when gestures were accompanying a positive statement and the subordinate hand when the statement was negative (Casasanto & Jasmin, 2010). In addition, Brunyé et al. (2012) found biases in spatial memory for positive information presented on the right side and negative on the left side for right-handers and the opposite bias - for left-handers. While some studies used either off-line task or free observation, other studies focus on “on-line” support for the body-specificity hypothesis measuring reaction time (RT). Generally, the research showed that participants were faster categorizing positive stimuli with their dominant hand and negative ones - with their subordinate hand (de la Vega et al., 2012; Kong, 2013). Similar results were observed responding with legs (de la Vega et al., 2015) or with crossed hands (de la Vega et al., 2013). Importantly, the crossed-hands experiments indicated that emotional valence is mapped with the hands rather than with the space[1].

Taking into account that most people have dominant hand and consequently experience more fluency within the space around that hand, concepts represented on the base of motor fluency should be stable. However, another line of experiments (Casasanto & Chrysikou, 2011) accentuates the

[1] Although the research showed that hands and not space are associated with emotional valence, we continue to use the convenient term “space-valence association”.

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importance of motor experience showing that individuals which are exposed to motor fluency changes (due to a stroke or performing a difficult fine motor task) reversed their space-valence associations (Casasanto & Chrysikou, 2011). In addition, this effect was shown when participants merely observed someone else or imagined themselves performing a disfluent motor action (see Kominsky & Casasanto, 2013; de la Fuente et al., 2015; de la Fuente et al., 2017). These studies demonstrate the crucial role of motor experience in our representation of valenced abstract concepts.

However, the one-trials off-line paradigm (Casasanto, 2009) cannot answer the question how crucial is the currently experienced motor (dis)fluency for the representation of the abstract concept of valence in terms of online processing.

The aim of the present exploratory research was to test whether changes in motor fluency would be strong enough to cause an on-line reversal in the implicit associations between valence and horizontal space. Across two experiments valence categorization of abstract nouns was used. RT was chosen as a measure of the word processing that participants were unlikely to manipulate or control. Experiment 1 replicated, extended and confirmed previous RT findings on space-valence association. Experiment 2 applied a motor (dys)fluency task where afterwards the participants were run through the same procedure used in Experiment 1.

Experiment 1. RT valence word categorization

Experiment 1 aimed to replicate previous findings (de la Vega et al., 2012; Kong, 2013) that showed faster RTs for categorizing positive stimuli with a dominant hand and faster RTs for categorizing negative stimuli with a subordinate hand for both left- and right-handed participants. In addition, we aimed at extending the results including ambidextrous participants who were equally fluent with both hands.

Method

Participants 117 (31 males) participants took part in the experiment. Most of them were university students and participated either voluntarily or in exchange for course credits. They all provided informed signed consent for the participation. The procedure was approved by the local Ethics Committee. A special care was undertaken to find more left-handers and ambidextrous participants through social media and personal contact.

Stimuli, Design, and Procedure The stimuli consisted of 96 abstract emotional words (48 positive and 48 negative). 72 of them (e.g., "*love*", "*grief*") were target words. 16 (e.g., "*harm*", "*benefit*") were "warm-up" words further excluded from the data analysis. 8 (e.g., "*respect*", "*rage*") were practice words also excluded from the analysis. All target words were matched for word length measured in number of letters, word frequency and emotionality strength.

The experiment had a 3x2x2 mixed factorial design with valence (positive vs. negative) and response hand (left vs. right) as within-subject factors and handedness (right vs. left vs. ambidextrous) as a between-subject factor. The dependent measure was the RT for categorizing words as either positive or negative.

Participants took part in the experiment individually. They were seated in an experimental booth facing a 17-inch LCD monitor with 1024×768 resolution from 50-52 cm distance. Written instructions were presented on the monitor to inform the participants that an emotional word would appear on the screen and they should be as fast and as accurate as possible categorizing the word as either positive or negative. Participants were required to use the keyboard: either "z" key (left hand) or "3" key (right hand) for word categorization. Response mapping was counterbalanced within-subject. Each trial started with a black fixation cross presented on a white background for 500 ms followed by a word presented in the middle of the screen. All stimuli appeared in black, 24 pt., Courier font against white background. The word remained on the screen for 3000 ms or until a response was given. Intertrial interval was set to 1000 ms. The experiment was divided in two blocks in order to counterbalance the response positions. Additionally, the order of button mapping was also counterbalanced across participants. The "warm-up" words were presented in the beginning of each experimental block (8 per block) in order to give more time to the participants to get acquainted with the task and the response mapping. Before the start of each block participants had a practice session with 8 practice words that did not appeared in the experimental part. The 8 words were repeated twice (16 practice trials). The experimental part contained 36 target-words and 8 "warm-up" words. E-prime 2.0 controlled stimuli presentation and responses (Schneider, Eschaman, & Zuccolotto, 2002); the experiment took about 12 minutes to complete.

Results and Discussion

Overall, data of 26 subjects (22%) were excluded from the analysis. Data of 15 of them were outside of the predefined ranges for the three handedness groups (see below). Data of 11 other participants were excluded for either non-completion of handedness inventory (3), reporting eye problems (1) or having low accuracy (below the estimated threshold of 90%; 2 participants). Finally, five subjects had participated twice so their second data record was excluded. Participants' handedness was measured with a modified scale that included 20 questions concerning hand use (14 questions), leg (2 questions), eye (2 questions) and ear (2 questions). The individual score was calculated based on averaged item-scores – the range was between 1 (completely left-handed) and 3 (completely right-handed). Right-handers were classified as having between 2.5 and 3 points, left-handers – below 1.5 points, and ambidextrous – between 1.75 and 2.25 points. Between each handedness category, a 0.5 points were left as undefined for participants who could not clearly be assigned to one of the handedness group. From the remaining 91 participants (23 males), 55 were classified as right-handed, 19 - as left-handed and 17 – as ambidextrous. Their age ranged from 18 to 43 years, with a mean age of 25 years (SD = 5). Error analysis was not performed since the overall level of accuracy was high (97,1 %). Prior to the RT analysis erroneous responses (2.9%) and response times lying more than ±2 standard deviations (SDs) from the RT mean per condition were removed (4.6%).

RTs were averaged by subject and data were submitted to rANOVA with two within-subject factors (valence: positive vs. negative and response hand: left/right) and one between-subject factor (handedness: left vs. right vs. ambidextrous).

rANOVA revealed significant three-way interaction between valence, response hand and handedness ($F(2, 88)=15.35$, $p<0.001$, $\eta_p^2=0.25$) shown in Figure 1.

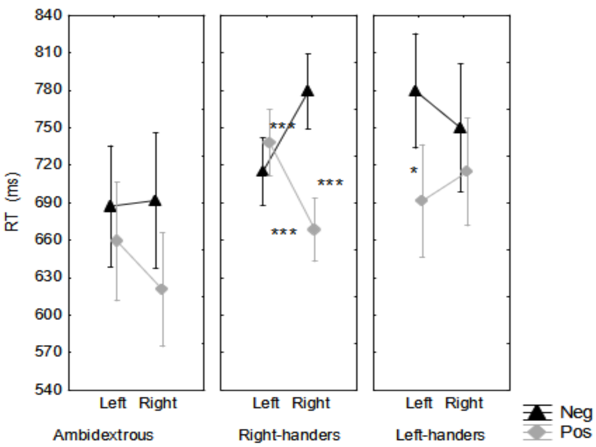

Figure 1: Experiment 1. A response hand by word valence by group interaction. Horizontal line represents response hands. Vertical bars denote 95% CI. * p<0.05; *** p<0.001.

Bonferroni post-hoc test showed that right-handers responded faster to positive stimuli with their right hand than with their left hand (668 vs. 738 ms; p<0.001) and faster to negative stimuli with their left hand compared to the right one (715 vs. 779 ms; p<0.001). The only significant result observed with the data of left-handers was faster RT for positive than for negative stimuli when responding with a left hand (691 vs. 780; p=.004). Ambidextrous did not show any significant result. Further, there was a statistically significant two-way interaction between valence and response hand ($F(2, 88)=7.05$, $p=0.009$, $\eta_p^2=0.07$). The two-way interactions between handedness and valence ($F(2, 88)=1.13$, $p = .326$, $\eta_p^2=0.02$) and between handedness and response ($F(2, 88)=0.92$, $p=0.401$, $\eta_p^2=0.02$) position were not significant. A main effect of valence was found ($F(2, 88)=90.23$, $p<0.001$, $\eta_p^2=0.56$) with faster RT for positive (665 ms) than for negative (733 ms) words and a main effect of handedness ($F(2, 88)=3.31$, $p=0.041$, $\eta_p^2=0.04$) with faster RT observed by ambidextrous participants (665 ms) compared to right-handers (725 ms) and left-handers (710 ms). A main effect of the response hand was not significant ($F(2, 88)=2.74$, $p=.101$, $\eta_p^2=0.03$).

In order to achieve better understanding of the effects and be able to generalize beyond the concrete stimuli and participants, a Linear Mixed Model (lme4 package, Bates & Maechler, 2010) was carried out with valence, response hand, and handedness as fixed factors, and items and subjects as random factors (Model H_A vs Ho excluding the 3-way interaction). The results revealed that the model including a three-way interaction term (H_A) accounted better for the data ($\chi2$ (1, *N=91*)=30.64, $p < 0.001$).

The aim of the study was to test whether the associations between space and valence differ regarding peculiarities of the human body, in particular, their handedness. In line with previous research (e.g., de la Vega et al., 2012) the results revealed that the space-valence associations differ depending on the handedness of the participant. Right-handed participants showed "positive is right" and "negative is left" mapping. Further, left-handers responded significantly faster to positive than to negative words with their left hand. The effect for the right hand was weaker with no significant difference between positive and negative responses. Ambidextrous did not show any significant results. Thus, for them the space-valence association was absent. If to assume that motor fluency is a crucial factor in conceptual representation then as an explanation for the weak effect observed in left-handers could serve the fact that, generally, they live in an environment designed for right-handers. Daily they are forced to use their non-dominant right hand which may cause motor fluency to spread also to their subordinate hand. Another possibility for the weaker effect we observed is that left-handers (N=19) sample was too small compared to right handers (N=55) so this can influence the effect's magnitude. Thus overall, our expectations were confirmed: right-handed showed full space-valence association, left-handers showed a partial one, and ambidextrous – none.

Experiment 2. Motor fluency and space-valence associations

The aim of the second experiment was to further investigate to what extent the currently experienced motor (dis)fluency is a crucial factor for the space-valence association manifested on-line, on a processing measure (RT). In order to induce motor disfluency, the Domino task was adopted from Casasanto & Chrysikou (2011). The same word-categorization task used in Experiment 1 was applied. We reasoned that if the body-specific space-valence association is influenced by the recently experienced motor disfluency then right-handed people who experienced induced motor disfluency on their right hand should reverse their associative mapping. Such a result would not only be consistent with previous off-line findings (Casasanto & Chrysikou, 2011) but it would suggest online information processing dependency of abstract concepts on experienced motor fluency. Here we would like to remind that the study is an exploratory one and not preregistered so the results should be taken with a grain of salt.

Method

Participants Overall 75 university students participated in the experiment. All of them provided informed signed consent for their participation.

Stimuli, Design, and Procedure The experiment had a 2x2x2 mixed factorial design with two within-subject factors: valence (positive vs. negative) and response hand (left vs. right) and one between-subject factor - glove (right hand vs. left hand). This experiment used the same stimuli and procedure as Experiment 1.

The procedure was divided into two main parts. First part was developed to induce motor dysfluency and second part – to measure on-line space-valence associations after the induced dysfluency. First all participants performed a fine-motor task (*The Domino task*, adopted from Casasanto & Chrysikou, 2011). They were seated at a 120cm x 55.5cm table. Forty green and forty orange rectangle stickers were placed on the table, forming 8 rows, each of which had stickers placed approximately 12 cm apart from each other. The domino pieces were placed in a single box in the centre of the table. Participants were given a written instruction to place the dominoes on the squares using both hands simultaneously. In order to induce motor disfluency participants had to wear a bulky ski glove either on their right or on their left hand. The second glove was attached to the first one to make the task more difficult. When a subject moved his/her hand the second glove hanged down. The task was to arrange the dominoes upright placing them on the shorter side with the points facing to the participant. Participants were required to start with the top row and the outermost rectangle, completing the task row by row using both hands simultaneously. If a domino fell down, participants had to bring it back up before moving to the next domino. They were not allowed to assist the gloved hand with the un-gloved one or vice versa. Participants had 12 minutes to complete the task. If they were ready earlier, they had to put the dominoes back in the box again using both hands and to start arranging them again if any more time was left.

Immediately after finishing the 12-minute Domino task the participants were asked to move to an experimental booth. Participants performed exactly the same valence word categorization task used in Experiment 1. The whole experiment took about 25 minutes.

Results and Discussion

The same handedness procedure was applied (cf. Experiment 1), focused on right-handed only. Out of 75 participants' data ten were excluded (3 were ambidextrous; 1 was not a native speaker of the local language; 3 had response accuracy <90%; one confused the response mapping; and 2 participants were too slow so that RT trimming procedure would leave less than 60% of their data. The remaining 65 (87%) participants (14 males) were all categorized as right-handed. They ranged in age from 17 to 50 years, with an average age of 23 years (SD=6).

Prior to the RT analysis, erroneous responses (3.4%) and response times lying more than ±2 standard deviations (SDs) from the RT mean per condition were removed (4.9%).

The RTs were averaged by subject and submitted to a repeated measures ANOVA with two within-subject factors (valence: positive vs. negative and response hand: left vs. right) and one between-subject factor (glove: left vs. right). A three-way interaction was not significant ($F(1, 63)=2.85$, $p=0.096$, $\eta_p^2=.04$]. All two-way interactions (valence by response hand ($F(1, 63)=0.09$, $p=.768$, $\eta_p^2=0.00$), valence by glove hand ($F(1, 63)=0.95$, $p=0.335$, $\eta_p^2=0.01$), and response position by glove hand ($F(1, 63)=0.32$, $p=0.574$, $\eta_p^2=0.00$) did not reach statistical significance either. A main effect of valence was found ($F(1, 63)=48.74$, $p<0.001$, $\eta_p^2=0.44$) with faster RT for positive (732 ms) than for negative (775 ms) words. A main effect of response hand was also significant ($F(1, 63)=4{,}49$, $p=0{,}038$, $\eta_p^2=0.06$) with faster RT for responses with the right hand (747 ms) than with the left one (760 ms). A main effect of glove was not significant ($F(1, 63)=1.71$, $p=0.196$, $\eta_p^2=0.02$).

Here again, a Mixed Linear Model (lme4 package, Bates & Maechler, 2010) was carried out, with valence, response hand, and glove hand as fixed factors, and subjects and items – as random factors. The model H_A included the 3-way interaction, and the model Ho did not. The results showed weaker effect in favor of Model H_A ($\chi 2$ (1, *N=71*)=4.34, p=.037).

Previously, it was established that the associations could be easily reversed (off-line) by inducing a shot-term motor disfluency (Casasanto & Chrysikou, 2011). Our results showed that performing disfluent motor task led the associations to disappear. Right-handers who wore the glove either on their right hand (reversed handedness) or on their left hand (perceived handedness) did not show any space-valence associations.

To investigate the change of the space-valence associations as a consequence of the induced motor disfluency further, we compared the results between-experiments in the following manner: data of participants wearing a glove on their right hand (Exp.2) were compared with right-handed and with left-handed participants from Experiment 1 separately. In the first analysis (right-handed vs right-hand glove) the interaction would suggest a change in the processing of abstract concepts after the Domino task. Second analysis followed the logic and the results of Casasanto & Chrysikou (2011) that suggest that people who wore the glove on their right hand should reverse their association to a pattern similar to natural left-handers. Thus, here an absence of interaction would suggest a complete reverse of the associations after the Domino task.

Analyses Across Experiments

Right-handers (Exp.1) vs right-hand glove (Exp.2) The data were submitted to a 2 x 2 x 2 rANOVA with valence (positive vs. negative) and response hand (left vs. right) as within-subject factors and glove (no glove vs. glove on the right hand) as a between-subject factor. The three-way interaction was significant ($F(1, 86)=30.10$, $p<0.001$, $\eta_p^2=0.26$) as shown in Figure 2. As we know from Experiment 1 right-handers who did not perform the Domino-task responded faster to positive stimuli with their right hand than with their left one (668 vs. 738 ms; $p<0.001$), and faster to negative stimuli with their left hand compared to the right one (715 vs. 779 ms; $p<0.001$). The only significant difference established for participants wearing the glove on the right hand (Experiment 2) was faster RT for positive than for negative stimuli when they were responding with a left hand (746 vs. 808; $p=0.007$, Bonferoni post-hoc).

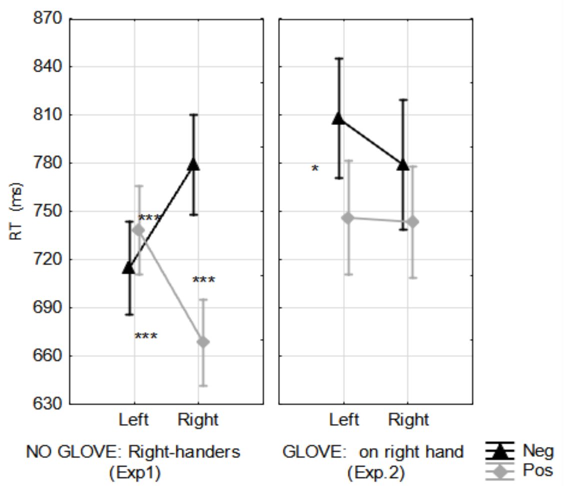

Figure 2: Experiment 1 and 2. Interaction between valence, response hand and subject group; right-handed from Exp. 1 and right-handed after the Domino task with the glove on their right hand from Exp. 2. Horizontal line represents response hands. Vertical bars denote 95% confidence interval. * - $p < 0.05$, *** - $p < .001$.

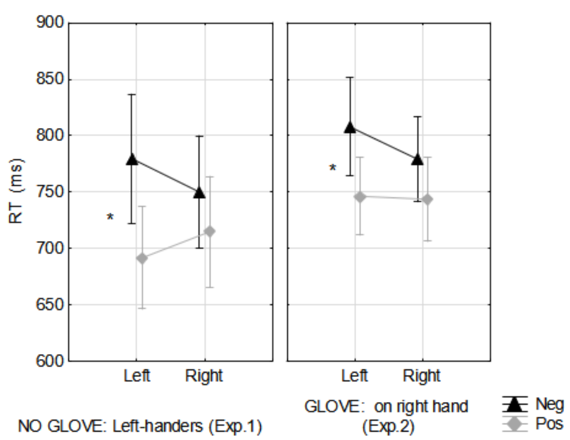

Figure 3: Experiment 1 and 2. Interaction between valence, response hand and subject group; left-handed from Exp. 1 and right-handed after the Domino task with the glove on their right hand from Exp. 2. Horizontal line represents response hands. Vertical bars denote 95% confidence interval. * - $p < 0.05$.

The effect for positive and negative stimuli disappeared completely, participants were equally fast responding to positive stimuli (746 vs. 743 ms) as well as to negative ones (779 vs. 807 ms) with both hands. The interaction between response hand and valence ($F(1, 86)=13.83$, $p<0.001$, $\eta_p^2=0.14$) was also significant. The other two interactions, between valence and experiment ($F(1, 86)=0.20$, $p=0.653$, $\eta_p^2=0.003$) and between response position and experiment ($F(1, 86)=1.53$, $p=0.22$, $\eta_p^2=0.017$) were not significant. A main effect of valence was found ($F(1, 86)=66.48$, $p<0.001$, $\eta_p^2=0.44$) with faster RT for positive than for negative words and a main effect of experiment ($F(1,86)=4.38$, $p=0.039$, $\eta_p^2=0.04$), with faster RT observed by right-handed participants in Experiment 1 compared to participant who wore the glove on their right hand in Experiment 2. A main effect of response position was not significant ($F(1, 86)=3.16$, $p=0.079$, $\eta_p^2=0.003$).

Right-handers (Exp.1) vs. left-hand glove (exp.2) The data were submitted to a 2 x 2 x 2 rANOVA with valence (positive vs. negative) and response hand (left vs. right) as within-subject factors, and glove (no glove vs. glove) as a between-subject factor. The three-way interaction was not significant ($F(1, 50)=0{,}41$, $p=0.523$, $\eta_p^2=0.00$) as shown in Figure 3. All two-way interactions (valence by glove ($F(1, 50)=0{,}65$, $p=0.419$, $\eta_p^2=0.01$), response hand by glove ($F(1, 50)=0.63$, $p=0.432$, $\eta_p^2=0.01$) and valence by response position ($F(1, 50)=3.60$, $p=0.063$, $\eta_p^2=0.06$) were not significant. Again a significant main effect of valence was obtained ($F(1, 50)=4.79$, $p<0.001$, $\eta_p^2=0.49$). The main effects of response position ($F(1, 50)=1.42$, $p=0.238$, $\eta_p^2=.02$) and of glove ($F(1, 50)=1.63$, $p=0.207$, $\eta_p^2=0.03$) were also not significant.

Overall, the results of both additional analyses confirmed that the fine motor task influences the space-valence mapping. After induced motor dysfluency right-handers changed their mapping into the mapping of 'natural' left-handers. Critically, the mapping change manifested itself in a processing speed.

Conclusion

The aim of the study was to investigate how the abstract concept of emotional valence is represented in the mind and to what extent the representation is influenced by the interaction of our body with the environment. Our exploratory research was inspired by the body-specificity hypothesis proposed by Casasanto (2009), according to which people have different mental representations of abstract concepts as a result of the peculiarities of their bodies. People tend to perform most of the tasks with their dominant hand which results in more fluent interaction with that hand. The experienced motor fluency associated with an action is positively (hedonically) marked (Winkielmann & Cacioppo 2001; Winkielman et al., 2003) which leads people to associate the motor fluency of a dominant hand with positive affect and the disfluency in the motor action of the subordinate hand with negative affect. Previous findings showed that the experienced motor fluency with the dominant hand caused left-handers to associate positive affect with the left space, and right-handers - with the right space (Casasanto, 2009; Casasanto, 2011). These implicit associations were manifested not only in an off-line measure (Casasanto, 2009; Brunyé, et al., 2012; Casasanto & Henetz, 2012; de la Fuente et al., 2015) but also in faster RTs when responding to positive words with the dominant hand and with faster RTs for negative words when responding with the subordinate hand (de la Vega et al., 2012; Kong, 2013). In line with this research, our Experiment 1 aimed at replicating previous results for categorizing positive and negative words by left-handers, right-handers, and extending the results including ambidextrous participants. Overall, the results were consistent with previous research, showing that participants were faster in categorizing positive stimuli compared with negative ones. The result is also consistent with the automatic vigilance hypothesis (e.g., Algom et al., 2004**)** according to which the more attention is paid to negative stimuli the slower the responses to negative stimuli are in comparison with responses to positive or neutral ones**.** Similar to the results observed by de la Vega et al. (2012) and Kong (2013), right-handers showed space-valence association, responding faster to positive than to negative stimuli with their right hand and faster to negative than to positive stimuli with their left hand. Left-handers showed the opposite RT profiles. The mean RT differences by left-handers were much smaller which can be related to different reasons. First, the left-handers (N=19) sample was too small compared to the right handers (N=55) which can influence the effect's magnitude. Second, we assume that left-handers may be forced to use more often their non-dominant right hand, since most of the devices in the environment are adapted for right-handed. Probably, this can lead to increasing the experience of fluency also with the non-dominant right hand by left-handers. Our assumption is two-fold: on one hand, space-valence associations are a consequence of experienced motor fluency as suggested by Casasanto (2009). On the other hand, left-handers interact more fluently with their subordinate hand than right-handers and also show less functional asymmetries than right-handers (e.g. Yahagi & Kasai, 1999). A possible consequence would be a weaker effect for left-handers compared to right-handers.

Another interesting case is the ambidextrous people who are supposed to interact equally fluently with both hands. To the best of our knowledge, such experimental group is examined for the first time in this research paradigm. Ambidextrous participants showed overall faster RTs responding to positive words than to negative ones but no interaction between valence and response hand was found. The results suggest that the fluent interaction with both hands cause the space-valence effects to disappear.

The aim of the second, exploratory, experiment was to further investigate the possible impact of motor fluency on the associations between emotional stimuli and the space around dominant and subordinate hands. Previous research showed that currently experienced motor fluency has a crucial role for the implicit associations between space and valence. When performing a fine motor task for only 12 min participants showed reversibility of the space-valence associations with right-handers showing "*left is good"* association and left-handers showing "*right is good* associations" (Casasanto & Chrysikou, 2011). Our experiment, however, used an on-line processing measure (RT). The categorization task was preceded by a fine-motor task inducing disfluent motor experience of either the dominant hand or the subordinate one. We expected that induced subordinate hand disfluency would either strengthen or not change the space-valence association pattern of right-handers and that induced dominant hand dysfluency would reverse the pattern. Although our expectations were not completely fulfilled, the obtained null result we can (carefully) take as a consequence of the induced motor disfluency. The RT pattern observed in right-handed participants looked exactly like the pattern of "natural" left-handed participants (Experiment 1). Unexpectedly, when the glove was on the left hand (perceiving natural right-handedness) the effect of the space-valence associations was not found either. We suggest that this can be due to the peculiarities of the Domino task where participants were required to move both hands simultaneously. In this case the un-gloved hand experienced some disfluency as well, strong enough to cause the effect to disappear. Our interpretation is indirectly confirmed by previous research showing that mere observation or imagining motor dysfluency (de la Fuente et al., 2015; de la Fuente et al., 2017) caused a reverse in space-valence mapping. Taken together, the results cannot completely support the idea that changing the fluency reverses the conceptual mapping (Casasanto & Chrysikou, 2011). Our results suggest that first, dysfluency caused space-valence mapping to disappear in both, glove-dominant and glove-subordinate hand cases. Which would mean, arguably, that the experienced motor disfluency is not bounded to the concrete hand but rather to the whole situation. Thus, probably, hedonic marking is also not related only to the fluency in the hand-motor interaction but is, probably, distributed across the whole situation where disfluency is experienced (Winkielmann & Cacioppo, 2001; Hayes et at., 2008). Second, the additional analyses suggested that the dysfluency made the right-hand glove-wearing group to behave similarly to the natural left-handers. Thus, in a way, the conceptual mapping changed and partially reversed after the experienced motor dysfluency. Most importantly, our results suggest processing changes in conceptual mapping caused by a simple motor procedure. It leads to a possible conclusion that representations of abstract concepts of valence cannot be considered being stable and unshakeable, moreover, it supports the view that representations are constructed ad hoc (Casasanto & Lupyan, 2015). Casasanto and Lupyan (2015) offered an ad-hoc cognition framework according to which concepts do not "exist" passively in the mind but they come to existence only when we use them.

To conclude, our exploratory results seemingly supported the critical role of motor (dys)fluency in processing of abstract concepts showing a change of space-valence mapping system on-line, and suggested that the concept of valence is constructed ad-hoc depending on the context.

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