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A Review Paper on Body Specificity Hypothesis and Its Testbeds

Yunjia Jia[1, *], Yuxuan Li[2, *], Fengyue Liu[3], Gaolexin Jiang[4]

[1]Applied Psychology and Human Development (APHD), Ontario Institute for Studies in Education (OISE), University of Toronto, Ontario, M5S 1V6, Canada

[2]Department of Psychology, McGill University, Montreal, Quebec, H3A 0G4, Canada

[3]Zhengzhou Foreign Language School, Zhengzhou, 450001, China

[4]North Broward Preparatory School, Florida, 33073, USA

*Yunjia Jia and Yuxuan Li contribute equally to the article.

Abstract

The Body Specificity Hypothesis is a hypothesis proposed by Daniel Casasanto in 2009. According to Body Specificity Hypothesis, people should form different mental representations when they interact with the environment in different ways. The hypothesis has been validated by more than a hundred studies since it was proposed a decade ago. Most of these studies have used the bodily characteristics of headedness as a test bed to determine how people with bodily differences develop correspondingly different thoughts and responses. In our study, we reviewed the evidence that right-handers and left-handers who perform actions in different ways in a systematic manner will perceive and represent information from the environment in different ways. In addition to handedness as a test bed, we also investigate other kinds of body specificity testbeds such as visual experience, pain sensitivity and experiences of verticality. It turns out that bodily differences can lead to differences in human cognition and action. In the last part, we also designed an experiment using footedness (natural preference of one's left or right foot) as variables and look forward to supporting this hypothesis in the future.

Keywords

Body Specificity Hypothesis; Testbeds; Mental representation; Handedness.

1. Introduction

The Body Specificity Hypothesis posits that the body-specific movement experience shapes the way we think, feel and the decision-making process. Some of the recent studies have used handedness as the testbed for the hypothesis. Neural evidence for the body-specific hypothesis has been found in the study called the body-specific representation of action verbs [1]. Researchers compared the pre-motor activity of the right-handers and left-handers in understanding the action verbs. According to the results of the study, the left front motor cortex of the right-handers has been preferentially activated when right-handers are making lexical decisions for manual action verbs compared to non-manual action verbs, while the right front motor area of the left-handers has been preferentially activated in the same process. The results confirmed the fact that during the language process period, people's implicit mental stimulation is different according to their handedness which means it's body-specific [1]. Another study uses abstract concepts of positive or negative valence to test the body-specificity of people's mental representation of information. The proponent of this hypothesis carried out the study called the embodiment of abstract concepts and figured out that the mental representation of information can be affected by the way people interact with the world. It turns out that among

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right-handers and left-handers, the way they map the spatial location to emotional valence is different [2]. The association between emotional valence and spatial location has been observed when participants reacting to the abstract concepts. Brunyé and his group extend the testing of mental representation differences between left and right handers to spatial memory. It turns out that right-handers misremember the positively- and negatively- valanced positions as positions that are further right and further left relative to their original positions, the opposite is true for left-handers. The results of this study have provided another piece of evidence to support the body-specificity hypothesis which is that handedness can influence the way people understand and represent the emotional valanced information internally [3]. To further demonstrate the body-specificity hypothesis, Brookshire and Casasanto investigated the association between the body-specific patterns of motor actions and emotional-related behaviors, and it shows that the association does exist. To better observe the neural activity of the participants' brains during the emotional motivation process, the researchers used electroencephalography (EEG) to measure the pattern of alpha-frequency bands in the brain. It turns out that the hemispheric laterality of affective motivation varies with handedness, it is reversed between right- and left-handers [4]. The studies above all focused on how handedness can influence the way people think or behave. Based on this physical attribute (handedness), people with different dominant hands interpret and represent the information from the surrounding environment differently. However, the test bed for Body Specificity Hypothesis is not limited to handedness, there are many other kinds of bodily differences that can be used to test how differences in the body lead to differences in the brain. In this article, we come up with different testbeds for the Body Specificity Hypothesis.

2. Body Specificity of Visual Experience

Body-specificity hypothesis implies that people with different traits should experience the world differently [5]. By holding various mechanisms, people should perceive the world and organize information in different ways. Visual experience plays a vital role in the cognitive process and it helps people perceive and understand the world from their perspectives. Besides, it is an important part of encoding the information into memory for most of us. Thus, it is easy to think that sight and blind people who have different visual experiences should have different methods to memorize and retrieve information from their memory. Bottini and his colleagues use visual experience as a testbed to find evidence supporting the body-specificity hypothesis.

In the experiment, researchers studied whether visual experience serves as an essential role in setting up a connection between serial order in working memory (WM) and spatial processing [6]. Three groups of participants with different visual experiences including early blind (EB), late blind (LB) and sighted participants were tested in an auditory WM task. Firstly, during the encoding phase, participants were asked to hear a list of words and to memory the word sequence. Secondly, these words would be played out of order selectively and participants needed to classify the words they heard each time as a fruit (press left button), or as a vegetable(press left button), or not in the word list (no action). At last, during the control phase, participants would hear the word list again and decide whether it was in the same order. According to the result, the authors found that both sighted and LB groups had a faster left-key response for the earlier words in the list, while for the EB group, they did not have any effects related to serial order in WM and space tendency.

Generally, as authors described, people use spatially organized devices to offload WM, which an Ordinal Position Effect will occur [6]. For example, white-boards and notes are both spatially organized devices that can give people actual experiences by writing down. Thus it is easy for sighted people to structure information in spatial media and retrieve it from memory by "looking" for the location of that information. However, EB people who never have this access

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can only rely on mnemonic devices which are less spatially organized. As a result, compared with sighted and LB, who can use spatial mapping to memorize and retrieve information, EB uses a different mental representation method to do so for they have different sensorimotor experiences.

Another experiment tests the differences in conceptual retrieving by examining the neural bases between sighted and EB people. Bottiniet and his colleagues focused on exploring brain areas that encode the perceptual similarity of action and color when hearing the words [7]. In the test, participants need to rate the similarity of these concepts in fMRI. The authors found that during the adaptation process, sighted people activated the posterior occipital cortex while EB people have stronger activation in temporal regions. Compared with sighted people, who rely more on a visual cortex to perceive and understand, EB people depend more on a lexical-semantic code that focuses on the temporal lobe during the cognitive process.

According to the authors, modality-specific simulation theory provides an explanation [7]. As sighted people did deep conceptual retrieving, the simulators were activated and doing simulations on the occipital cortex, which helps people to understand. However, EB people who lack this simulator were not able to do the simulation in their region. In turn, they need more support from the temporal lobe, where the Brocas-Wernicke area serves more for them to understand.

In conclusion, Bottiniet and his colleagues' researches on visual experience supported the body-specificity hypothesis. That is different bodies with different mechanisms have various internal minds and methods to interact with the external world. As a result, people perceive the world in different ways, for they use different 'eyes' in mind to see the world. Besides, it is interesting that EB and LB have different results in the first task. The specific time of blindness may also bring different situations across people during the cognition process, which could be a new testbed in clinical settings in future studies.

3. Body Specificity of Pain Sensitivity

According to the body-specificity, people who have different ways to interact with the world have differences in cognitive processing [5]. As a result, it is logical to judge that different body sensitivity influences people's perception of the world. Researchers have found that people's emotional sensitivity has important effects on specific cognitive tasks [8-9]. Thus, It is reasonable to consider that pain sensitivity could be a specific testbed to find whether it could influence people's ways to construct concepts and word meanings [10]. One more reason that pain sensitivity could be a good variable for testing the body-specificity hypothesis is that it differs within culturally homogeneous populations, and it allows to reduce other factors or possibilities to explain the situation [10-11].

To test this proposal, Reuter and his colleagues andomly assigned participants and presented them with a group of words including pain-related nouns, positive nouns, negative nouns, and neutral nouns [10]. Words types vary from concrete words like 'hammer' and 'bones' to abstract nouns like 'birth' and 'torture'. After each word presented, participants need to give a score of the pain-relatedness of the particular word on a 5-point scale. Finally, they self-assessed their pain sensitivity, pain frequency, and emotional sensitivity by a survey. Researchers found that compared with those with lower pain-sensitivity, people with higher pain-sensitivity are easier to associate words with pain in their mind. Besides, for concrete words, the differences are greater for people in the ratings of high and low pain sensitivity groups. This result can be further explained that individuals differ in their sensitivity to pain, which means they experience or perceive the pain stimuli differently, will lead to a different understanding of the word meanings. As a result, it supported the body specificity hypothesis, that is people's bodies shape their thoughts and feelings [5].

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Three possible mechanisms could explain the results, attention and memory biases, prototype analysis, and embodied theory [10]. According to the authors' analysis, for the first mechanism, the data failed to support it because the results faild to indicate a significant relationship between pain sensitivity and pain frequency [10]. As a result, we can't interpret that the more frequent experience of pain for high pain-sensitivity people, the more memory bias they have. For the second mechanism, it was interpreted that highly pain-sensitivity people would record more painful experiences as exemplars related to concepts. However, the mechanism failed to explain the research result, since comparing pain-related words groups and control words groups, no significant differences was found [10]. Lastly, from the view of embodied cognition, people are different in simulations of the concept of pain and perception, which form different pain matrices. As a result, reading a pain-related word will activate those brain regions, which will be activated as people experiencing pain in the real world [10]. The different simulation processes lead to differences in understanding pain-related words. This could be reasonable because it can explain the different results across concrete versus abstract words.

Comparing these three models, it seems that the embodied theory could be the best explanation. However, people who suffer chronic pain could be special examples. They have different comprehension for pain compared with others [12] . This could be a new direction for future study in clinical settings

4. Body Specificity of Experiences of Verticality

Slepian and his colleagues focused on examining whether experiencing verticality can influence people's construal level [13]. Experiencing relatively high or low influences people's perception and representations. Lakeoff and Johnson stated that 'good is up', 'bad is down', which show a relationship between metaphor mechanism and cognitive judgment [14]. Combined with the body specificity hypothesis, sensorimotor activations by experiencing verticality and metaphor mechanism may both influence people's abstract or concrete processing of information.

In Study 1, by approaching people who experienced ascending versus descending a staircase, researchers found that participants who walked up (ascending) and experienced high verticality would construe a simple action in a higher level way which means understanding the intention rather than just action. This result provided evidence that the construal level could varies according to individual's verticality experiences. In Study 6, researchers found that by providing pariticpants with minimal experiences of verticality, which is tested in a virtual scene (presenting images), can have an impact on consture level [13].

In Study 2, they found that experiencing high verticality caused participants to give up the immediate but less money. In turn, they chose to gain the future but more money [13]. The reducing temporal discounting shows a better self-control ability, which long-term but larger gains were perceived as more meaningful compared with short-term gains for people experiencing high verticality. However, according to Lakeoff and Johnson, the orientational metaphors affect people's conceptual structure,e.g "more is up" [14]. Thus, the result may be due to another possibility that participants linked the concept of "high", which was experienced vertically with "bigger" gains. To test further, in Study 5, researchers combined a word-stem task with the tasks in study 2 to find whether the semantic activation of concepts plays a role in this relationship between verticality and construal. Besides, they added conditions to test whether verticality movement affects the result. They found that superficial semantic association did not predict temporal discounting, nor as to the movement. That is, the experience of verticality alone takes accounts [13].

In study 3, the authors considered that a high verticality might offer a positive mood for participants, which could bring better performance in construal tasks [13]. To test this proposal, they asked participants who experienced ascending or descending steps to complete a

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categories task including strong versus weak exemplars. After rating the degree of belonging for each exemplar to the categories, they were asked to self-report their current mood. Researchers found that the experiences of high verticality elicit abstract thinking. Participants perceived meaningful links between categories and items more frequently [13]. However, the mood did not play a crucial role in it. Study 4 additionally tested the influences of feeling power and arousal by experiencing high verticality but did not find any pieces of evidence that these two factors could affect the result significantly [13].

In study 7, by offering participants a cube with a dot in the corner and asked questions implied high or low construal level (why question versus how quesiton), researchers found a reciprocal relationship that is, by answering abstract question or concrete questions, participants's construal level can influenced their verticality perspective. It extends Lakeoff and Johnson's idea about metaphor and cognition [14]. As the author stated, the sensorimotor metaphor can ground a cognitive processing style.

These studies support the body-specificity hypothesis that the sensorimotor cortex, which was activated by physical experiences, provides a simulation, which facilitates people's information processing [5]. Specifically, people's experiences of verticality, as the authors' example, standing at top of mountains of looking out of the window, can influence the way of construing the world, in turn, forming a different perception. The result can be further tested by people's creativity and goal pursuing, or other mind processing areas.

In conclusion, visual experiences, pain sensitivity and experiences of verticality could be good testbed for the body specificity hypothesis and they supported it significantly with crucial experiments. Besides these three areas, there could be other possible testbeds. In the last part, we designed an experiment using footedness as variables and look forward to supporting this hypothesis in future.

5. Experiment

Does foot preference effects the cognition of abstract time.? In order to test whether people who take left foot or right foot first will understand and organize the order of several time segments faster and clearer, we choose to test the understanding of abstract time by arrange a list of random, fictional time periods into a timeline. We were inspired by a previous study which discovered that mirror reading can reverse the flow time. Considering the reading order of a timeline is from the left to the right, so that our hypothesis that people who take left foot first will have better understanding of abstract time than people who take right foot first.

We predict that when organizing the time periods into timeline, people who take right foot first need shorter time than people who take left foot first.

6. Subjects

Five-hundred subjects in all ages include children, adults and the old will be gathered to attend this experiment. They will come from any social group. The number of male and female who attend the experiment will be even. Since we want to keep the result precise, the subjects will not have any mental or physical problem.

7. Material

The work needs a big room and let the subjects sit behind their own tables. In front of the room, researchers will put a big board and use the machine to show powerpoint to subjects. The context of the powerpoint is come pieces of time period(eg. 204-233, 1983-1989). The powerpoint has only one page to show the time period (eg. 204-233, 1983-1989). There will be pencils and paper for subjects to draw the timeline. Then timekeepers will be on each of the desks to test the total time each subject used to finish drawing the timeline.

8. Method

The purpose of this experiment is to find out the relationship between people's foot preference when walking (they prefer to take left foot first or right foot first) and the ability to organize abstract time, that is, whether they are sensitive to time because of foot preference. So the work can get the subject's response time according to the abstract time period.

The first step is to gather together all of the subjects to a room and separate them into two groups. The first group is made-up of subjects who take left foot first and the other group is made up of ones who take right foot first when walking. After they sit down, they will be shown 5-6 random pieces of time period(eg. 204-233, 1983-1989) on the screen in the front of the room. The pieces of time period are absolutely random and will be made up by researchers. None of the number groups will be related to historical events or some typical daily matters like festivals. In this way, the subjects will not be interpreted by their previous memory of the time. Subjects will be given 20 seconds to see all of the pieces of time period roughly and 20 seconds to organize the time before they draw the timeline on paper. The researchers will ask the subjects to press the timekeeper when they start to draw the timeline. If they finish drawing the timeline, they will press the timekeeper immediately. After all of the subjects finish the timeline, researchers will collect the time each subject in the two groups used and the timeline they drew.

Then researchers will collect the data from the subjects about how much time they spend on organizing and drawing the timeline. Data from different groups will be analyzed separately to find out the law of digital change. If the data of one group of the subjects shows a tendency that most subjects in this group use less time to understand and organize the time period, the result is about which kind of people(take left foot first/ right foot first) have better ability to understand abstract time. Finally, we can figure out the relationship between understanding of abstract time and foot preference.

9. Conclusion

In total, according to the experiment, this work will get the result and test which of the predictions is correct. The experiment will help to find out which group of people will be more sensitive to abstract time organization and understanding. So if people who prefer to use their left foot first when walking use less time to draw the timeline, Prediction 1 is supported, vise versa.

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