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Choosing with the head:
"embodiment" effects in preference expression

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Abstract

Research from the embodiment perspective shows that not only language understanding but also other higher cognitive processes, such as judgment and evaluation, can be based on sensorimotor experiences. Studies that have reached this conclusion have found effects of compatibility between the evaluation of concrete or abstract, positive or negative, linguistic expressions, and the movement of various parts of the body. The present study examines motor compatibility effects between nodding and shaking gestures and the evaluation of the truth value of sentences expressing subjective preferences. This test was made possible by an experimental design that allowed to control objects on the computer screen directly with head movements. Shorter response times resulted when sentences evaluated as true were moved vertically and those evaluated as false were moved horizontally. This pattern, found with subjectively evaluable expressions, confirms previous results obtained when objectively true or false sentences were evaluated with the same movements of the head. Possible explanations of the relationship between these two types of assessment and the two head gestures of nodding and shaking are discussed, with

particular reference to social and cultural factors and to some critical aspects presented by this perspective.

Introduction

According to *embodied cognition,* a growing trend in cognitive sciences, cognitive processes are grounded in sensorimotor experience (Glenberg 1997; Goldstone and Barsalou 1998; Casasanto 2009), including social and nonverbal aspects (Niedenthal et al. 2005; Barsalou et al. 2003). A central concept in this approach is the compatibility relation between bodily states and cognitive states. In general, inside this perspective, all studies concerning the comprehension of verbal expressions share the idea that cognitive processing proceeds smoothly when bodily actions are "compatible" with the meaning of these expressions.

In the literature two kinds of "compatibility" have been studied: spatial or motor compatibility. Spatial compatibility studies (e.g. Dudshig et al. 2013) have found a faster response when the position of a word on the screen was consistent with the position of its referent, as typically perceived in the space (like the word "bird" appearing on the upper part of the screen). Studies on motor compatibility (e.g. Glenberg and Kaschak 2002), on the other hand, have found faster response times when the direction implied in a sentence was consistent with the direction of the motor action to be executed as a response (like the sentence "You give me a pen" and a hand movement towards the body).

Two kind of sentences have been analyzed in this kind of research: objectively understandable and subjectively evaluable. In the first case, focus is on the relation between a bodily state, or an action, and simple comprehension of the meaning of a concrete word or sentence (Šetic and Domijan 2007; Pecher et al. 2010). In the second case, the relationship is with evaluation (a higher-order process consisting in judging connotative meaning, affective value, agreeableness, etc.) of abstract or valenced (Lakoff and Johnson 1999; Proctor and Cho 2006; Casasanto 2009; Meier and Robinson 2004). In both cases, spatial and motor compatibility effects have been found.

Studies about motor compatibility effects mainly involved limb movement and required sentence understanding (Glenberg 1997; Glenberg and Kaschak 2002; Borghi et al. 2004) or the evaluation of positive-negative valence of a stimulus (Horstmann and Ansorge 2011;Niedenthal et al. 2005). For example, studies involving arm movement found a faster response when a positive stimulus was evaluated through an approach movement (arm push-up toward the body) and vice versa when the stimulus was negative (e.g., Neumann and Strack 2000; Cacioppo 1993; Wentura et al 2000; Chen and Bargh 1999). Embodiment effects considered in these studies concern the *simultaneous* and automatic activation of traces of an action compatible with the processed content.

Studies involving head movements, however, have only investigated a kind of compatibility where an action is first induced and effects are found on the processing of a *subsequent* stimulus. For example, Wells and Petty (1980) found that participants, who were asked to move their heads up and down while listening to music and messages through headphones, agreed more with the content of messages compared to participants who were asked to shake their head left and right. Similarly, Brinol and Petty (2003) found that a message received while nodding can be more persuasive. In line with this research, other studies showed that induced nodding and shaking head movements can influence the evaluation of positively or negatively valenced objects (Forster 2004), or create an attitude for a neutral object (Tom et al. 1991).

All these studies induced in participants nodding and shaking movements in order to investigate their influence on higher-level cognitive processes like evaluation or memory. This way they showed how such two gestures can be significantly involved in the production of attitudes and emotions, accordingly with their social meaning. However, this kind of studies only investigated the effect of gestures on cognition. On the contrary, there are still no inquiries about how during linguistic processing experiential traces linked with head gestures can be activated or inhibited. In our previous research (Moretti and Greco, under review) we found that the evaluation of objective true or false statements can be embodied in these gestures. Since nodding and shaking gestures can express agreement or disagreement but also acceptance or refusal, it seems plausible to test the presence of similar compatibility effects also with subjective evaluations (like expressing preferences). We believe that this kind of investigation can be useful for bringing new evidence on the relationship between sensorimotor mechanisms and higher-level cognitive processes. Also, it can cast new light on the possible link between objective and subjective evaluations of the truth value of linguistic expressions. To this purpose, we designed a new experiment, using the same paradigm of previous ones, asking to evaluate sentences expressing personal preferences, whose truth value is a subjective option.

Experiment overview

The experiment had the aim of testing a motor compatibility effect between vertical and horizontal head movements and a complex cognitive evaluation such as assessing the truth value of contents expressing judgments or preferences. A facilitation effect was expected in a truth evaluation task when the movement required for evaluating a sentence as true was vertically oriented, thus consistent with the usual head movement for "yes", and as false when the movement was horizontal (usually performed to say "no"). On the contrary, when movement directions were inverted, an interference effect was expected.

Similarly to previous experiments (Moretti and Greco, under review), sentences were presented on the center of the screen and participants were asked to evaluate their truth value and drag them to one of four side bars, labelled as "true" or "false" according to the experimental condition. In the *compatible* condition two green bars labelled "true" were on top and bottom screen and two red bars labelled "false" were on the left and right; in the *incompatible* condition the bar location was inverted. The possibility of moving sentences by head movements, without using the mouse, was provided by a software which through a webcam detects head movements and converts them into pointer action.

Sentences expressed first-person judgments about different food, for example: "I like marmalade", "I hate chocolate" (negative expressions like "I

don't like…" were not used) and participants were asked to evaluate if they were true or false according to their personal preferences and drag the sentence to the appropriate sidebar. Preferences about food were chosen in order to avoid that social desirability effects could bias the process, supposing that food preferences can be expressed without a particular concern or pride.

Response times were recorded from the moment when the central box was clicked and the sentence appeared, to the moment when the box started to be moved. These times can be considered as times required to sentence processing (understanding meaning, judging truth value, deciding response direction).

At the end of the main task, participants were asked to answer an explicit questionnaire, requiring to rate on a scale the likeability (I like, I don't like, Indifferent) of all food included in sentences previously evaluated with the head. This way possible inconsistencies in answers were checked and items were excluded concerning food which in the final questionnaire was rated contrary to the head experiment, or rated "indifferent".

A detailed description of the experimental procedure and full results can be found in the Appendix.

Discussion and conclusions

Overall results support the hypothesis that even the subjective evaluation of truth can be embodied in the usual vertical and horizontal head movements of nodding and shaking. Among different bodily expressions, these two gestures are important communicative social signals of agreement and disagreement and are usually associated with positive and negative contents (Morris 1979; Jakobson 1972). According to Forster and Strack (1996), when thoughts or feelings are strongly associated with certain movements or body states, and normally occur together, behaviors associated to these cognitive states seem to be activated faster than those not associated. Thus, even if it is possible to show some behavior which is incompatible with our own cognitive states (e.g. to smile when we are unhappy, or to nod when we do not agree with another person), nevertheless this performance requires a greater effort.

A dual interpretation can be made of the compatibility effect found in the present study. According to the *motor resonance* theory (Zwaan and Madden 2005), our results would show that processing an information which is evaluated as true automatically reactivates traces of the vertical head movement usually performed when one gives positive or affirmative responses, and similarly would happen with false information and horizontal movements.

An alternative explanation would be given by the "approach-avoidance" model (Chen and Bargh, 1999; Wentura 2000). The concept of subjective truth, intended as "true or false according to a personal point of view" could be embodied into an approach movement, because the head is moved from the top towards the body, and falsity with an avoidance movement because the head is pulled away from the body in either side. Besides, a first physiological explanation of the "head nod-shake system" was already included in the Darwin (1872) book about the expression of emotion in man and animals. According to this theory, the origin of these two head gestures could be traced back to the childish actions of accepting or rejecting food.

Some general, still open, questions about embodiment effects apply also to our results. For example it is still discussed whether and how much embodiment aspects are required for conceptual processing. Further, it is not clear at which degree the activation of sensorimotor system is automatic, and at what level of the process such activation might occur (e.g. understanding truth value, or subsequent decision of response direction). Since generally the facilitation or inhibition of some processing is detected by measuring

response times, the simplest interpretation would put this effect on the earlier processing levels, because faster response times are considered as the direct consequence of the activation of automatic processes.

Another important question concerns whether the relationship between body actions and cognitive processing is innate or acquired. In our case, nod and shake are a widespread practice in Western culture, but they do not have a universal meaning since different cultures express agreement or disagreement with different head movements. For example, the same gestures in Bulgaria have exactly the opposite meaning; in Greece, Turkey, and southern Italy, to say "no" the head is pushed backwards and upwards, and to say "yes" it is pushed forwards and downwards; in some areas of Iran and of Bengala, people swing their heads to say "yes" (Morris 1979).

Thus it would be interesting to explore if the compatibility effect obtained with head movements is universal or cultural. We are indeed proceeding this study in a transcultural direction, by engaging a Bulgarian sample. Ascertain whether the same pattern or an inverted pattern results, would bring interesting implications for the debate, with particular reference to the cultural specificity hypothesis of embodiment (Andonova and Taylor 2012).

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Appendix

Participants
27 students (17 female, mean age 23.0, ds 6.6) participated for course credit. They had normal color vision and normal or corrected-to-normal visual acuity. Informed consent was obtained at the beginning of the experiment.

Apparatus
The experiment was controlled using a custom program written in Visual Basic 6. In order to control the mouse pointer on the screen with the head, the Enable Viacam v.1.7.2 free software was used (CREA Software, released under the GNU General Public License, www.crea-si.com, with the following settings: X-axis speed 12, Y-axis speed 9, acceleration 2, motion threshold 0, smoothness 3; dwell click enabled, dwell time ds 10, dwell area 3). This software makes use of a common webcam mounted on the top center of the monitor to capture head movements and to convert them into pointer motion. A Logitech C210 webcam was used, allowing the required 30 fps rate.

Materials
120 simple sentences expressing preferences about food were used. Half sentences expressed a positive preference (e.g. "I like" or similar expressions) and half a negative one. A total of 60 different sentences were displayed in each block, in a different random order for each participant.

Procedure
The experiment was divided into two blocks. In the compatible block the direction of the movements to be made for evaluating the truth of sentences was consistent with the usual direction of the two head gestures (true-vertical, false-horizontal), whereas in the incompatible block they were inverted (true-horizontal, false-vertical).

Two groups were established in order to counterbalance the order of the compatible - incompatible conditions in the two blocks across participants. Participants were assigned randomly to one of two groups, A (13) and B (14). In Block 1, participants in group A had the compatible condition, in group B the incompatible condition. In each experimental session, after that Block 1 had been completed, the response pattern was inverted in Block 2.

The task consisted in dragging sentences which appeared in white into a black box at the screen center toward one of bars placed at the four screen sides, labelled TRUE or FALSE according to the experimental condition.

Instructions informed participants that the study was about food preferences, and that their task was to fast moving each sentence, expressing like or dislike about one food, to the bar indicating TRUE or FALSE according to their personal preference.

The sentence appeared when the participant stared at the central box, which was considered as a click by the program. Response times were recorded from the moment when the sentence appeared to when the participant started to drag it (when the box was moved by at least 20 pixels from the starting point, either horizontally or vertically), which was considered the time required for sentence processing. Times taken to reach the target bar were not considered.

At the end of the main task, a questionnaire was presented which required, for each of 60 food, to express a personal preference by choosing between three options: I don't like it, I like it, Indifferent (in this order).

Data analysis

The first 8 responses in each block were considered additional practice and were eliminated. Outlier response times (less or equal than 700 ms and greater than or equal 2000 ms) were also eliminated. Only consistent responses were considered, thus contradictory or uncertain responses were excluded from analysis. In particular, were eliminated responses expressing with the head a preference different than the one given in the final questionnaire (1%), or different between Block 1 and Block 2 (5.4 %), or when dragging was started in a different direction than the one of the target actually reached (12.6 %). Further, responses on food rated Indifferent at the final questionnaire were not considered (7.9%).

Linear Mixed Modeling (LMM, Baayen, Davidson, Bates, 2008), was used in order to simultaneously take into account the variability due to between-subjects and between-items differences. Software R 3.3.2 was used, with lme4 package (Bates, Maechler, Bolker, & Walker, 2015). F statistics have been obtained with the Anova function of the lmerTest package (https://cran.r-project.org/package=lmerTest). Degrees of freedom have been estimated with Satterthwaite approximation. Given the particular technique used for moving the sentence object on the screen, some long response times resulted and a right-skewed distribution, even after outlier elimination, resulted. Logarithmic transformation was thus adopted for data.

Results

LMM model included response times (RTs) as dependent variable, compatibility as independent variable, participants and item as random factors, with random intercepts for both variables. In incompatible conditions RTs resulted significantly longer (Fig. 1) [$F(1,1603)=24.99$, $p < .0001$].

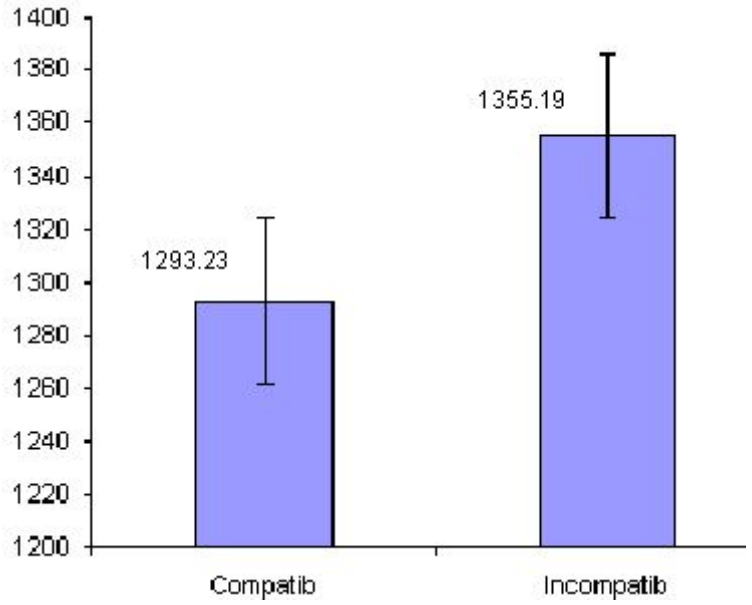

Fig.1 - Average RTs estimated for compatible and incompatible conditions (log values have been back-transformed for clarity of interpretation). Bars indicate standard error.

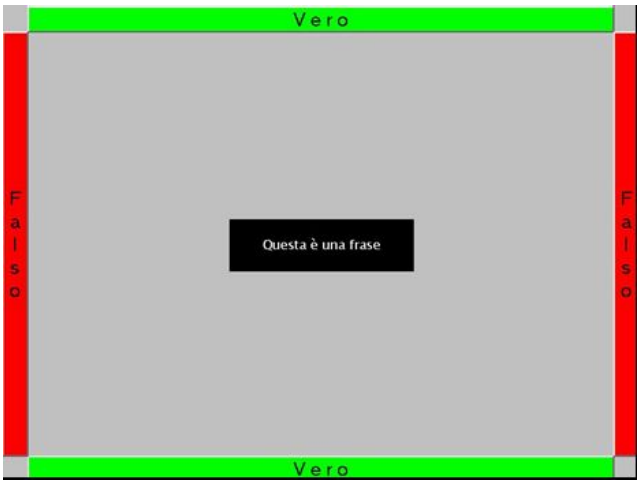

Fig.2 - Example of screen in the main task, compatible condition (true=vertical, false=horizontal).

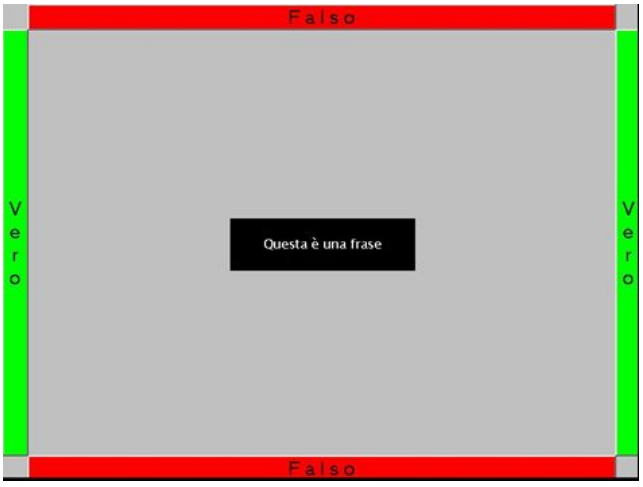

Fig.3 - Example of screen in the main task, incompatible condition (true=horizontal, false=vertical).