Negation processing in action: How action path is interpreted in a negated context?

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Introduction

Studies suggest that language interferes with motor system which in turn influences action perception at a very early stage of human development (Scutti et al. 2016). This top-down influence of language on non-linguistic processes can be used to guide observer's attention in an action demonstration task (Rohlfing et al. 2006). Studies of this kind often use a simple assertive verbal description concurrently with the action, and disregard the context of the event as it unfolds. Given that an occurring subevent is interpreted in light of the past event, a simple assertive guidance might not be suitable to demonstrate an action varying along the perceptual dimension e.g., visual contrast. A contrastive instruction (in form of assertion first followed by a negation) could be more appropriate to guide such a progression of an action since it reduces cognitive load and promotes fine grained understanding (Lipton 1990, Miller 2021). Till date, the effect of verbal and visual contrast on action understanding and its associated cognitive load has barely been investigated. To address this question, in an eye-tracking study, we measured simultaneously the action recall and pupillometry for contrastive and noncontrastive action sequences in presence of verbal instructions with different degrees of contrast. A combination of negative and assertive verbal instruction was used for this purpose because it has been shown that negation can be contrasted against its positive counterpart and provides a rich contextual information (Wason 1965).

Methods

Participants (N=30) were presented video stimulus in which a ball was moved in relation to three different landmark objects (Fig. 1), creating a noncontrastive (Up–Up, Down–Down) or contrastive (Up–Down, Down–Up) action sequence. Each video segment (pre- and post) was accompanied by either assertive or negative instruction, creating a verbal sequence of assertive (e.g., Up–Up), negative (NotUp–NotDown), an assertive-negative (Up–NotUp) or a negative-assertive (NotUp–Up), whereas a video without instruction (no voice) was treated as a baseline. A sequence of assertive and negative voice instruction was considered as contrastive when compared to a sequence with only assertive or negative instructions. As a dependent measure, we assessed the action recall and pupillometry measure in a performance task where participants performed each action sequence immediately after watching the videos on an eye-tracking screen without time limitation.

Results

Results show the effect of verbal contrast on offline recall of action (Fig 2a) and cognitive load (Fig 2b). For the recall, there was significant main effect of action path and voice such that recall for contrastive action was higher than non-contrastive action sequence and the recall for assertive sequence was higher than no voice (Base). This effect suggests that verbal instructions were overall

helpful for action recall. There was a significant interaction between path and voice such that recall for the contrastive action was better in assertive-negative voice condition suggesting that contrastive instructions enhanced the recall for the contrastive action i.e., Up–Down or Down–Up. To measure the load associated with the action with different voice instructions we used pupil size as a marker for task difficulty and cognitive load (Dretske 2018). The results shows that there was a significant decrease in pupil size in later time window for contrastive action in presence of contrastive verbal instruction (assertion–negation).

Conclusion The results are promising in terms of designing a guidance for actions, according to which a sequence of assertive and negative verbal instructions could lead to a contrastive instruction which promotes the understanding of a contrastive action.

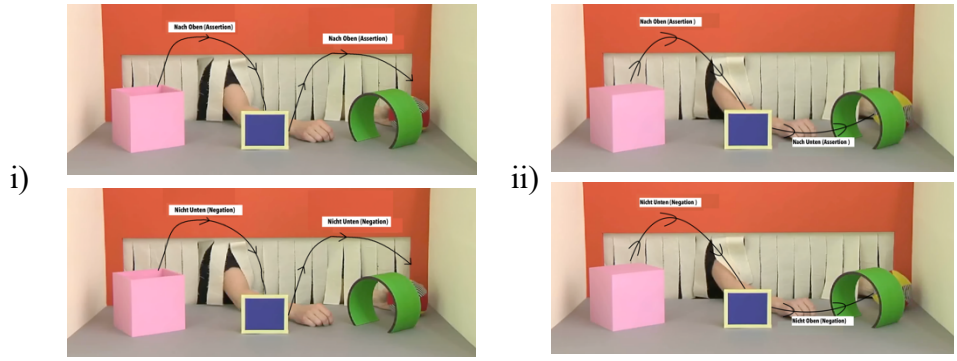

Figure 1. Example action sequence (i) noncontrastive (ii) contrastive; each motion window was accompanied by either an assertive (e.g., Up [nach oben]) or a negative (e.g., NotDown [nicht unten]) verbal instruction.

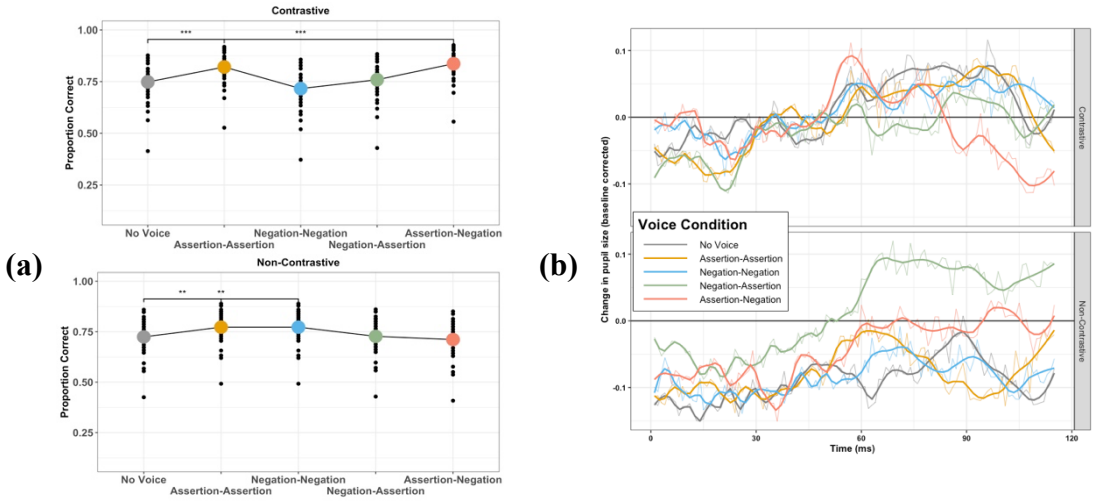

*Figure 2. Results for (a) action recall and (b) pupil size for different voice instructions. Recall is enhanced in contrastive condition with assertion-negation (contrastive) voice instruction (a) and decrease in pupil size (b); * Corresponds a significant difference.*

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