

# 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 [4]. This top-down influence of language on non-linguistic processes can be used to guide observer's attention in an action demonstration task [3]. 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 [2] [1]. Till date the relationship between verbal and visual contrast in action understanding has barely been investigated. To address this question, in a recall task we evaluated the effect of verbal contrasts (assertion and negation) on the visually contrastive and non-contrastive motion. We use negation since it creates verbal contrast and provides a rich contextual information when interpreted against its positive counterpart [5].

## Main Objectives

- 1 To test whether a verbal contrast - a sequence of assertive and negative description of the action path - enhances recall of a visual contrastive action as opposed to a sequence of simple assertive description
- 2 Using an eye-tracker, we evaluated whether contrastive verbal instructions reduce cognitive load while observing a contrastive action as suggested by contrastive explanation literature [2] [1]

## Methods

- 1 Participants: 30 students, age(mean) = 23.90
- 2 Stimulus: Action videos in which a ball was moved against three landmark objects creating non-contrastive (Up-Up/Down-Down) or contrastive (Up-Down/Down-Up) action sequence (Fig. 1)
- 3 Conditions: Each video segment (pre-and post) was accompanied by assertive or negative path description (Fig. 2), creating a sequence of either two assertives (e.g., Up-Down), two negatives (not Down-not Up) or assertive-negative (Up-not Up) instructions, where a video without instruction (no voice) was treated as a baseline
- 4 Procedure: Participants watched the videos on an eye-tracking screen and then performed the action on a stage. All the trials were counterbalanced and presented in random order

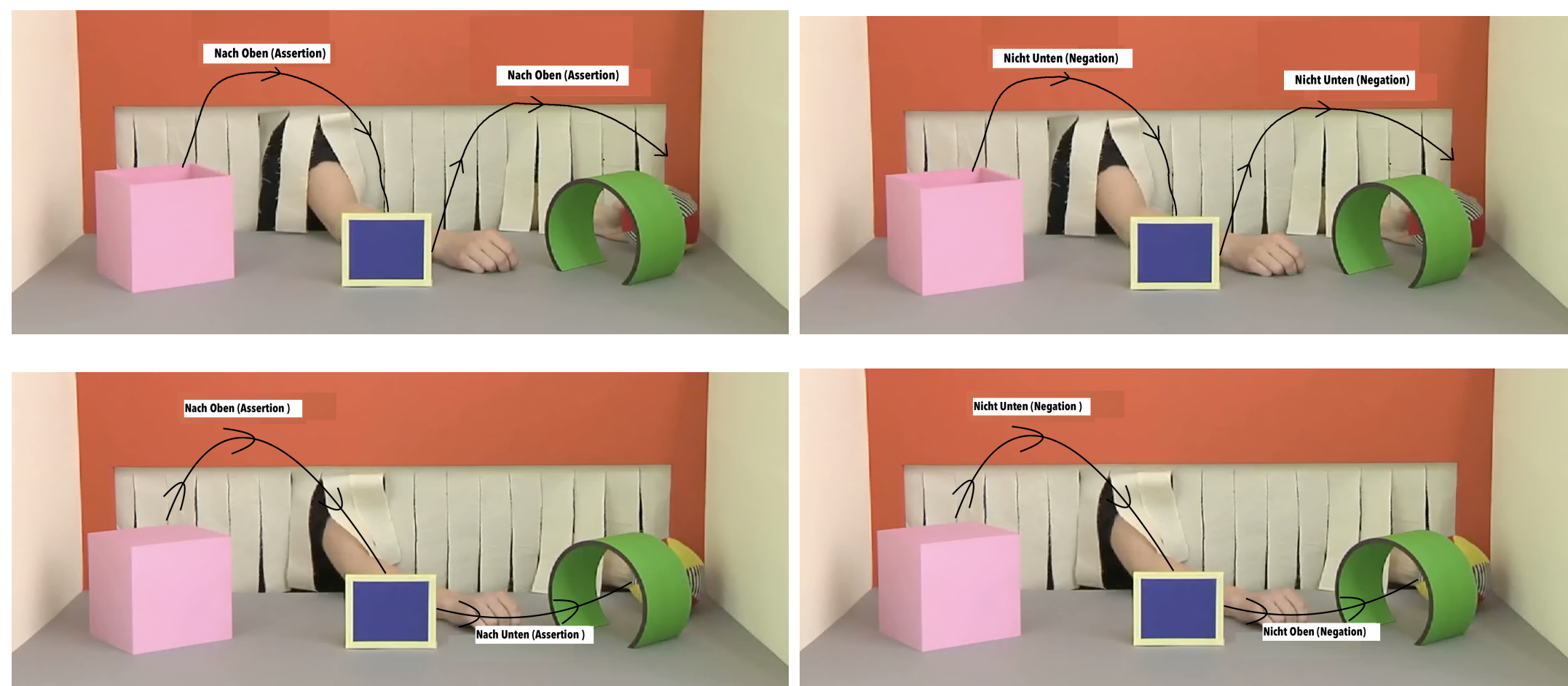


Figure 1: Example action sequences (a) non-contrastive (i.e., Up-Up) and (b) contrastive (Up-Down) with assertive and negative instructions respectively

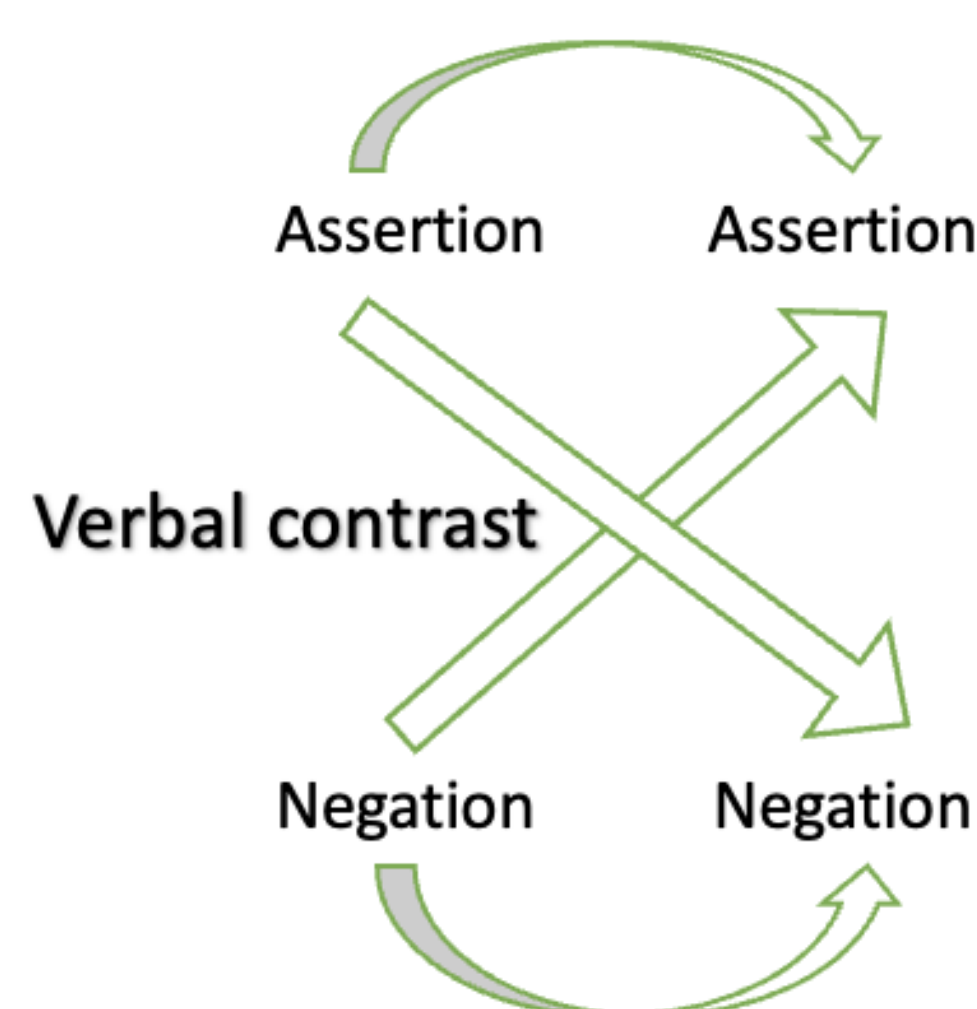


Figure 2: Verbal conditions for contrastive and non-contrastive action sequence

## Results

- 1 A significant main effect of action path such that recall for contrastive action was higher than non-contrastive action sequence (Fig. 3)
- 2 A significant main effect of voice such that recall for assertive-assertive was higher than no voice (Base), suggesting that assertive instructions were overall helpful for action recall
- 3 A significant interaction between path and voice; a pairwise comparison shows that the assertive-negative voice condition enhanced the recall for the contrastive action paths i.e., Up-Down or Down-Up
- 4 Eye-Tracking results (Fig. 4): A significant interaction between voice and path such that there was a significant decrease in pupil size in later time window for contrastive action in presence of contrastive verbal instruction (assertion-negation)

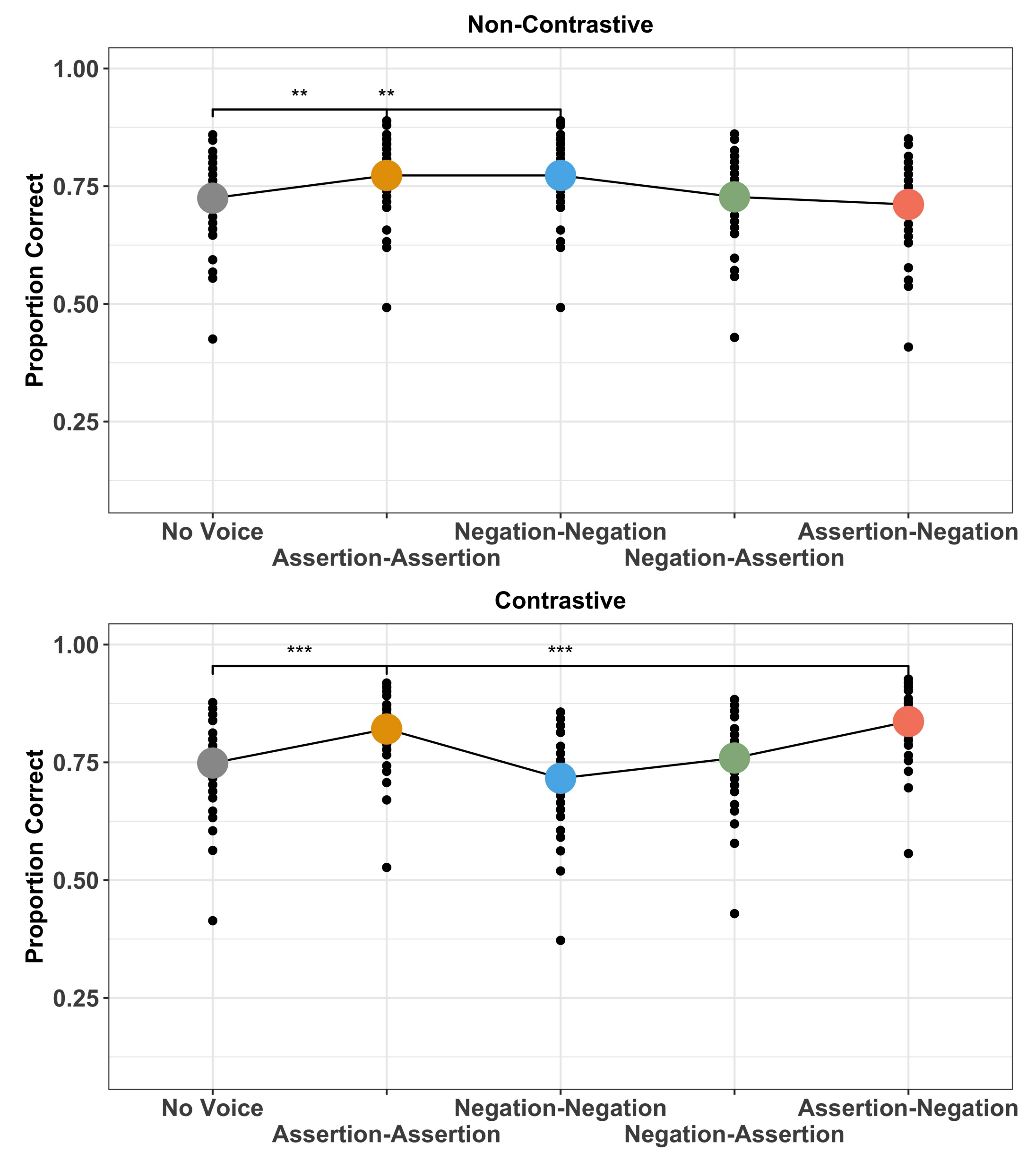


Figure 3: Proportion of correct recall for non-contrastive and non-contrastive action for different voice condition (\* shows a significant difference)

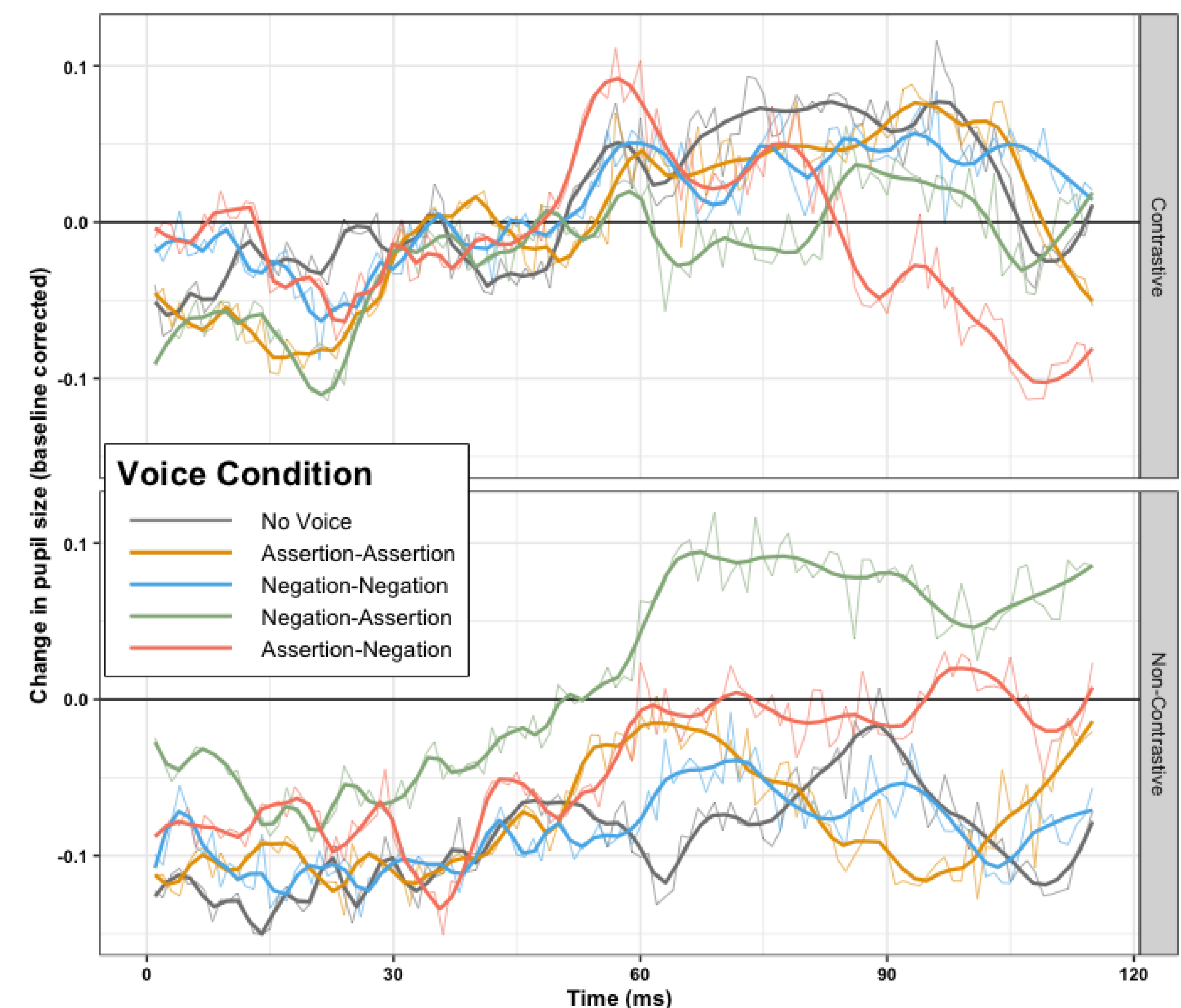


Figure 4: Change in pupil size for contrastive and non-contrastive action observation for different voice condition (baseline corrected)

## Conclusions

- A contrastive action contains sub-actions where the later is the opposite of former, we show that such actions can be better demonstrated by combining assertion-negation instruction which reveals a rich contextual information that cannot be achieved alone by assertive instruction [5]
- Most studies treat action as discrete sub-events by giving only assertive verbal instruction, we show that negation instead can be used to provide a contextual understanding of a contrastive action
- Contrastive verbal guidance reduces cognitive load for contrastive action, which might facilitate contrastive action understanding

## References

- [1] P. Lipton. Contrastive explanation. *Royal Institute of Philosophy Supplement*, 27:247–266, 2021.
- [2] T. Miller. Contrastive explanation: A structural-model approach. *The Knowledge Engineering Review*, 36(E14), 2021.
- [3] K. J. Rohlfing, J. Fritsch, B. Wrede, and T. Jungmann. How can multimodal cues from child-directed interaction reduce learning complexity in robots. *Adv. Robot.*, 20:1183–1199, 2006.
- [4] A. Sciutti, K. Lohan, G. Gredebäck, B. Koch, and K. Rohlfing. Language meddles with infants' processing of observed actions. *Front. Robot. AI*, 3(46), 2016.
- [5] P. Wason. The contexts of plausible denial. *Journal of Verbal Learning and Verbal Behavior*, 4:7–11, 1965.