

# The geometry of the Landmark Task

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## 1. Introduction

In the Landmark Task participants are shown a horizontal line divided into two segments by a transection mark (“landmark”), and asked to compare the lengths of the two segments [3,4]. This comparison can in principle be carried out by (i) considering the stimulus as a single object and assessing whether or not it is left-right symmetrical [1], or (ii) interpreting the two segments as separate objects, mentally translating one over the other and deciding whether they are congruent (see also [2,5,6]). When stimulus lines are rectangles, which is typically the case, the two types of process cannot be easily distinguished because symmetrical stimuli are (by definition) formed by two congruent segments and non-symmetrical stimuli are formed by non-congruent segments. The purpose of this work is to separate out the contribution of symmetry processing from that of translation-congruency processing by using trapezoidal instead of rectangular shapes.

## 2. Methods

### 2.1. Participants

Overall, 46 university students (F: 37; age  $24.3 \pm 3.2$ ) with normal or corrected-to-normal vision, *naïve* to the purpose of the study, volunteered in two separate experiments.

### 2.2. Stimuli

180-mm long, black lines on a white background were used. The Landmark – a 0.7-mm thick, 20-mm

long vertical red line – was located centrally (half the trials) or in one of four eccentric positions ( $-7$ ,  $-3$ ,  $+3$ ,  $+7$  mm). The two segments separated by the Landmark could be either rectangular (4-mm thick) or trapezoidal (2.6 to 5.4 mm thick), and were arranged in four types of configuration (see Fig. 1A), following a  $2 \times 2$  design in which Symmetry – whether or not the stimulus was symmetrical with respect to the Landmark, and Repetition – whether or not the two segments were congruent after horizontal translation, were varied independently. Note that when the landmark was eccentric, stimuli were never properly *symmetrical* or *repeated*; we will use the terms *pseudo-symmetrical* and *pseudo-repeated* in these cases.

### 2.3. Procedure

Participants viewed a 15” 16:9 computer screen from a distance of 57 cm. All 256 stimuli were presented at screen centre in random order, with a  $256 \times 256$  random dot mask being presented during the inter-stimulus interval. Neither a time limit nor specific instructions to respond quickly were given – indeed we were interested in the spontaneous strategies elicited by the Landmark task, without time pressure.

### 2.4. Left-Right (LR) Experiment

Twenty-nine participants had to decide which segment was the longer, left or right, by pressing one of two keys with the index (“left”) or middle (“right”) finger of their right hand.

### 2.5. Same-Different (SD) Experiment

Seventeen participants had to decide whether the two segments were equal or different in horizontal length, by pressing one of two keys with the index (“same”) or middle (“different”) finger of their right hand.

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eccentricity, and roughly equal for central and 7-mm stimuli. These patterns were again compatible with the assumption of a more conservative response criterion applied in SD than in LR.

### 3.2.1. Same-Different task

The pattern was fully consistent with the hypothesis of active use of symmetry, with a significant main effect of Symmetry [ $F(1,16) = 27.841, p < 0.001$ ] on central, and no effect on eccentric landmarks [ $F(1,16) = 0.455, p = 0.509$ ].

### 3.2.2. Left-Right task

Symmetry was again a significant predictor for central landmarks [ $F(1,28) = 4.948, p = 0.034$ ], but an unexpected result emerged from eccentric landmarks: a significant Symmetry X Repetition interaction [ $F(1,28) = 17.942, p < 0.001$ ], suggesting that the  $> | >$  category poses some additional difficulty with respect to the other three categories (see Fig. 1B). We also compared  $< | <$  and  $> | >$  but failed to find any significant difference in RT or accuracy.

## 4. Discussion

In the Same-Different version of the Landmark task the prediction of the *symmetry processing* hypothesis was fully met.

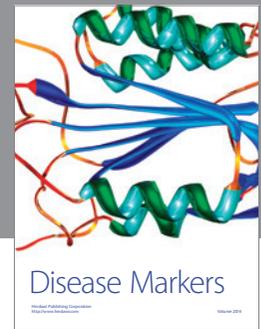
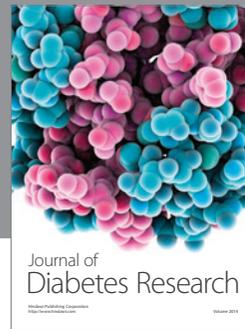
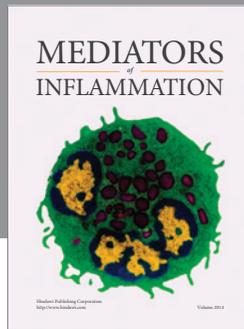
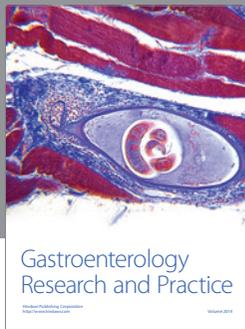
Data from the Left-Right task were also compatible with the symmetry processing hypothesis, in that an effect of Symmetry was found for central-landmark stimuli. However, a puzzling pattern emerged from the eccentric landmarks, i.e., a selective *disadvantage* for non-symmetrical repeated stimuli ( $< | <$ ). An interpretation in terms of some form of symmetry processing would be supported by the advantage of  $= | =$  over  $< | <$  (see Fig. 1, bottom-right plot), but is contradicted by the absence of any such effect between

$> | <$  and  $= | <$ , which also differ for (a)symmetry. Neither does an account in terms of mental translation hold: if anything, it would have predicted an *advantage* for  $< | <$  over  $= | <$ ; instead, a *disadvantage* was observed. We speculated that the overall geometrical structure of  $< | <$  might suggest a double arrow pointing leftwards, and thus possibly interfere with response selection. However if this had been the case, a spatial compatibility effect would have emerged, with “left” response being facilitated in the case of  $< | <$  and inhibited in case of  $> | >$ , and vice versa for “right” responses. However no such effect emerged. So we still lack an obvious explanation for this data configuration.

Overall, these data strongly suggest that symmetry processing, and not mental translation, is the main strategy applied by normal participants to solve the two typical versions of the Landmark Task.

## References

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