The Influence of Aging on Perceptual Grouping in Haptic Search

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Abstract. Perceptual grouping speeds up haptic search. This has particularly been shown for grouping of distractors by similarity and good continuation [1]. Here, we investigated the effect of aging on grouping in haptic search. We reasoned that because older adults have less cognitive resources available for processing perceptual information, they would benefit more from grouping as compared to younger adults. We tested this hypothesis in a haptic search task in which proximity, similarity and good continuation of the distractors were manipulated. We found that older adults indeed show a larger effect of distractor similarity on search times as compared to younger adults, where similar distractors were processed faster than dissimilar distractors. However, older adults showed an opposite effect of grouping by proximity, where items that were further apart were processed faster. This may be caused by a strong bowed spatial position effect in older adults: stimuli that are closer to each other are more difficult to discriminate. We conclude that haptic perceptual grouping by similarity has larger benefits in elderly as compared to younger adults.

Keywords: Haptic perception · Aging · Perceptual grouping

1 Introduction

A well-known phenomenon in the process of aging is the decrease in cognitive resources that are available for perception, action, and other processes [2]. One strategy limiting the amount of cognitive resources that are needed is just doing one task simultaneously, another possibility may be to more efficiently use those resources. The aim of the current study is to investigate whether perceptual grouping reduces the amount of cognitive resources needed for haptic perception in older adults.

When only limited cognitive resources are needed to perform a certain task, age differences tend to be small, while when a task is complex, age differences arise [3]. This also holds in haptic 2D shape recognition: age differences in recognizing tangible line drawings of simple shapes were much smaller as compared to more complex representations of everyday objects, not only in terms of reaction times but also in accuracy [4].

In the current study we adopted the paradigm as used in the Overvliet et al. [1] study, where we show that perceptual grouping speeds up haptic search. If grouping reduces the amount of cognitive resources needed to perform such perceptual tasks, we

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expect older adults to benefit more from perceptual grouping as compared to younger adults.

2 Method

2.1 Participants

Twelve younger volunteers (mean age 24.67 ± 3.82, 1 left-handed, 4 males, 8 females) and 12 older volunteers (mean age 74.75 ± 3.67, 1 left-handed, 5 males, 7 females) from the university community were paid 8 euros per hour for their participation. The study was approved by the Medical Ethical Committee of the University Hospital Gasthuisberg (Leuven), and the participants gave written informed consent before starting the experiment. All participants had normal or corrected to normal vision but were blindfolded during the experiment.

2.2 Setup and Procedure

The task for the participant was to search for a target by moving two of their fingers down two columns of ten horizontal and vertical tangible line segments (length:1.5 cm, width: 1.4 mm, height: about 1 mm). A target was defined as a pair (one item from each column) that was different from the distractor pairs. The target could be located between position two and ten, counted from the top. We varied similarity, good continuity, and proximity of the distractor pairs (see legend of Fig. 1). We varied similarity by having similar distractor pairs and a dissimilar target pair (similar) or vice versa (dissimilar). For good continuity, we varied whether the distractors were aligned (vertical) or not-aligned (horizontal; in the similar conditions only). Lastly, we varied proximity in two ways: For spatial proximity (Experiment 1A) we placed the items close or far apart and for somatotopic proximity (Experiment 1B) the pairs of fingers used was varied: fingers from the same hand (near) or from opposite hands (far).

3 Results

Exploration time for different target positions was standardized by fitting a regression line through the data and the slopes of the different conditions were compared (Fig. 1). We ran a mixed-model ANOVA with factors age group (young vs. old), proximity (near vs. far) and similarity (different, same vertical, same horizontal). We specified contrasts to test the effect of similarity (different vs. same horizontal and same vertical) and good continuity (same horizontal vs. same vertical).

For Experiment 1A, we found significant main effects for age group $F(1,22) = 24.72$, $p < .0001$, $\eta_p^2 = .53$, spatial proximity, $F(1,22) = 6.26$, $p < .05$, $\eta_p^2 = .22$, and similarity ($F(2,44) = 90.27$, $p < .0001$, $\eta_p{}^2 = .80$). Moreover, we found significant effects for the same-different and the good continuity contrasts f($F(1,22) = 135.85$, $p < .0001$, $\eta_p^2 = .86$ and $F(1,22) = 8.70$, $p < .01$, $\eta_p^2 = .28$ respectively). For Experiment 1B, we found main effects for age group F

(1,22) = 53.21, $p < .0001$, $\eta_p^2 = .71$, somatotopic proximity $F(1,22) = 14.88$, $p < .001$, $\eta_p^2 = .40$ and similarity ($F(2,44) = 75.51$, $p < .0001$, $\eta_p^2 = .77$). We again found an effect for the same-different and the good continuity contrasts ($F(1,22) = 7.53$, $p < .05$, $\eta_p^2 = .26$ and $F(1,22) = 111.93$, $p < .0001$, $\eta_p^2 = .84$ respectively).

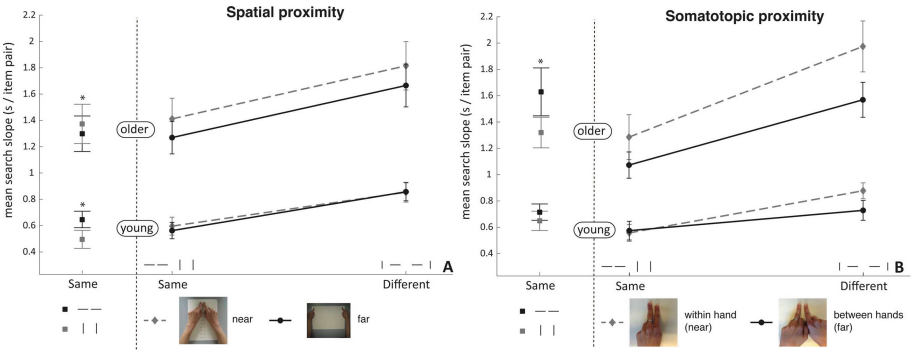

Fig. 1. The mean slopes of the regression lines for spatial proximity condition (A) and somatotopic proximity condition (B). Error bars indicate the standard errors of the mean over participants. The left panels in both figures show the good continuation manipulation. The pictures in the legend show the stimulus materials and proximity manipulations.

4 Discussion

We found that older adults indeed show a larger effect of distractor similarity on search times as compared to younger adults, where similar distractors were processed faster than dissimilar distractors. However, older adults showed an opposite effect of grouping by spatial proximity, where items that were further apart were processed faster. This may be caused by a strong bowed spatial position effect in older adults: stimuli that are closer to each other are more difficult to discriminate [5]. Age-related decline in tactile sensitivity and processing speed may explain general slower exploration by older adults [2], but it does not explain larger grouping effects. We conclude that haptic perceptual grouping by similarity has larger benefits in elderly as compared to younger adults.

References

1. Overvliet, K.E., Krampe, R.T., Wagemans, J.: Perceptual grouping in haptic search: the influence of proximity, similarity, and good continuation. J. Exp. Psychol. Hum. Percept. Perform. **38**(4), 817–821 (2012)
2. Salthouse, T.A.: The processing-speed theory of adult age differences in cognition. Psychol. Rev. **103**(3), 403–428 (1996)

3. Gick, M.L., Craik, F.I.M., Morris, R.G.: Task complexity and age-differences in working memory. Mem. Cognit. **16**(4), 353–361 (1988). https://doi.org/10.3758/BF03197046
4. Overvliet, K.E., Wagemans, J., Krampe, R.T.: The effects of aging on haptic 2D shape recognition. Psychol. Aging **28**(4), 1057–1069 (2013)
5. Adam, J.J., van Boxtel, M.P.J., Houx, P.J., van Gerven, P.W.M., Jolles, J.: Perceptual and motor factors mediate the bowed spatial position effect in ageing. Eur. J. Cogn. Psychol. **18** (5), 673–685 (2006)