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The visual perception of exocentric distance in outdoor settings

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ABSTRACT

The ability of 20 younger (mean age was 21.8 years) and older adults (mean age was 71.5 years) to visually perceive exocentric distances outdoors was evaluated. The observers adjusted the extent of in-depth spatial intervals until they appeared identical to fronto-parallel intervals of 4 and 8 m. The frontal and in-depth intervals were viewed from a distance of 8 m. Almost all of the observers' judgments were inaccurate and most reflected perceptual compressions in depth: e.g., an in-depth interval of 10 m would appear to have the same extent as a physically smaller 8 m frontal interval. Some observers' judgments, however, were consistent with perceptual expansions of in-depth intervals. No significant effects of age were obtained in the current study: both younger and older adults exhibited perceptual compressions and expansions of in-depth intervals. This outcome differs from that of a recent experiment conducted by our laboratory (Vision Research 109 (2015) 52–58) that found the judgments of younger adults to be less accurate than those of older adults. A comparison of the former and current results revealed that while older adults perform similarly outdoors and indoors, the accuracy of younger adults' exocentric judgements improves substantially in outdoor settings (so that the accuracy becomes similar to that exhibited by older adults).

Research conducted over the past 65 years has consistently demonstrated that human observers' perceptions of distances in depth can be surprisingly inaccurate. For example, Gilinsky (1951) asked participants to create equal-appearing intervals in depth within an indoor archery range (total distance was 80 feet, or 24.4 m). She found substantial compressions of in-depth intervals, such that one observer (e.g., see her Fig. 4) perceived a physical distance of 70 feet (21.3 m) as being approximately 40 feet (12.2 m) away. Thus, this observer's perceived distance was only 57% of the actual distance. Over the succeeding decades, other researchers have also found large perceptual compressions of in-depth intervals in outdoor settings (e.g., Harway, 1963; Loomis, Da Silva, Fujita, & Fukusima, 1992; Loomis & Philbeck, 1999; Norman, Crabtree, Clayton, & Norman, 2005; Wagner, 1985). Perceptual distortions of distances are not limited to outdoor environments; they also occur in indoor environments where observers are asked to judge the extent of shorter distances in depth (Baird & Biersdorf, 1967; Norman, Adkins, Norman, Cox, & Rogers, 2015; Norman, Lappin, & Norman, 2000; Norman, Todd, Perotti, & Tittle, 1996; Thouless, 1931). For example, Norman et al. (2015) used in-depth intervals whose extent varied from approximately 10–20 cm; their younger observers perceived these distances to be much smaller than they actually were (on average, the younger observers perceived these distances to be 59.4% of the actual extents).

Bian and Andersen (2013) investigated aging and egocentric distance (distance from oneself to a single point in space) perception and made an important discovery. In their study, younger and older observers estimated large egocentric distances in depth (4–12 m) in a large grassy field. The younger adults judged the egocentric depth intervals to be much smaller than they actually were (i.e., exhibited perceptual compression), whereas the older adults' judgments were accurate. Norman et al. (2015) followed up the Bian and Andersen experiments by investigating whether aging similarly affects observers' ability to perceive exocentric distances (distance between 2 locations in space irrespective of oneself) indoors. They found that while their older adults' judgments were inaccurate, they were nevertheless more accurate than the judgments of younger adults. The results of both of these studies (Bian & Andersen and Norman et al.) indicate that aging improves the ability to estimate distances in depth. Nevertheless, ambiguities remain. Do older adults always perceive distances more accurately than younger adults? Can older adults, for

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Fig. 1. Photographs of the grassy field where the experiment was conducted. The top and bottom photographs illustrate the 4 and 8 m conditions, respectively. On any given trial, the observer (left) instructs the experimenter (right) where to place a pole so that the produced depth interval equals the width between two frontally-oriented poles.

example, accurately perceive exocentric distances outdoors? The purpose of the current study was to answer such questions.

1. Method

1.1. Apparatus and stimulus displays

The apparatus was identical to that used by Norman et al. (2005). The spatial intervals to be judged on any given trial were marked by polyvinyl chloride (PVC) plastic poles (1.56 m tall × 2.7 cm diameter). At the top of each pole was a spherical blue 'target' (5.6 cm in diameter). The experiment was conducted outdoors on the WKU campus in a grassy field (see Fig. 1).

1.2. Procedure

The procedure was identical to that used in Experiment 2 of Norman et al. (2005). On any given trial, two poles were placed