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Multiletter identification studies often find correctly identified letters being reported in wrong positions. However, how position uncertainty impacts crowding in peripheral vision is not fully understood. The observation of a flanker being reported as the central target cannot be taken as unequivocal evidence for position misperception because the observers could be biased to report a more identifiable flanker when failing to identify the central target. In addition, it has never been reported whether a correctly identified central target can be perceived at a flanker position under crowding. Empirical investigation into this possibility holds the key to demonstrating letter-level position uncertainty in crowding, because the position errors of the least identifiable central target cannot be attributed to response bias.

We asked normally-sighted observers to report either the central target of a trigram (partial report) or all three characters (whole report). The results showed that, for radially arranged trigrams, the rate of reporting the central target regardless of the reported position in the whole report was significantly higher than the partial report rate, and the extra target reports mostly ended up in flanker positions. Error analysis indicated that target-flanker position swapping and misalignment (lateral shift of the target and one flanker) underlay this target misplacement. Our results thus establish target misplacement as a source of crowding errors and ascertain the role of letter-level position uncertainty in crowding.

Keywords: crowding, whole report, partial report, position uncertainty, letter identification

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(, 1970; , 2008; & , 1962). (, 2008),

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(, 1977; & , 1967; , & , 1990; , 1987; & , 1984). , 2005). (-

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M

P 20

(, 1973), (2005),

(2002) **A** (,)

$(2048 \times 1536, 75, 21-0.189, 520 \times 0.189)$
 $(0.8, 50 / ^2)$

10 (10,)
 30- (0 9)

S

(1)
 10 (, , , & ,
 2007). 10 (2.22
 2.02 / ; , 2007)
 , & , 2009).

1.5 2 60
 80 6 8 , 10
 12) (60 120 (6
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 (0.5% ± 0.2%)

D

$P = 1 - (1 - \gamma)e^{-(x/th)^\beta}$
 $(0.1, x, 0.3, \gamma)$
 β
 66.9%

P

& , 2002).
 10°
 P
 (1 2) 1600- (3) 200-

(), /
 , & (, 2006).
 (-) N /
 / 10,000
 / ” ”

a



b

Report rate

Stimulus size (arcmin)

0.2 0.8 (F_{1,3} = 5.64, p = 0.098, (F_{1,5} = 32.5, p = 0.002; 1 2). (F_{3,9} = 22.2, p < 0.001) (F_{3,15} = 25.9, p < 0.001). (0.6 0.8) 1600 (3). 0.6 0.8 53.2 ± 5.3 63.5 ± 6.3 1600 0.4 0.6 53.6 ± 5.6 63.4 ± 6.1 200 1600 0.001; 0.2 0.8 : p < 0.001; : p < 0.001). 1600- 0.8 (2); (2); (F_{1,5} = 27.78, p = 0.003, 2 0.6 1971). / (1969).

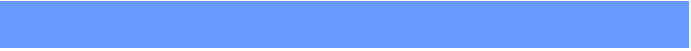
E 3:

≤ 200 1) 1600- (3) 66.9% 56.5 ± 5.6 1600- 26.0 ± 1.2 200- (1). (p < 0.001, (3), (F_{1,3} = 771.7, p = 64.8%. 35.2%, (2) 100% 35.2% < 0.001). 0.2 0.8 - 26.3%, 40.1% 200- 1600- 0.2 1 2 0.8 - 2

D

(1), 0.2 0.6 - 2

, 2 2
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35.2% 2
14.2% 2 2 -
12.1% ,
2 12.1% = 52.7%,
20% ,
80%.



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- (1970). *Nature*, 226(5241), 177–178.
- (1973). *Vision Research*, 13(4), 767–782.
- & (2009). *Vision Research*, 49(15), 1948–1960.
- & (2009). *Vision Research*, 49(23), 2782–2789.
- & (1998). *Vision Research*, 38(19), 2949–2962.
- (1977). & (), *Studies of Perception* (39–55). (1969). *Journal of Experimental Psychology*, 82(2), 279–284.
- & (1967). *Perception & Psychophysics*, 2(2), 573–576.
- & (1976). *Perception & Psychophysics*, 19(1), 1–15.
- & (2009). *Proceedings of the National Academy of Sciences USA*, 106(31), 13130–13135.
- & (2010). *Current Biology*, 20(6), 496–501.
- & (1990). *Psychological Research*, 52(1), 13–21.
- & (1996). *Nature*, 383(6598), 334–337.
- & (2006). & (), *Introduction to the Practice of Statistics (Fifth Edition)*. 1–70.
- & (2002). *Visual Cognition*, 9(7), 889–910.
- & (2001). *Cognitive Psychology*, 43(3), 171–216.
- & (2007). *The Journal of Experimental Psychology: Human Perception and Performance*, 33(1), 209–229.
- (1977). *Perception & Psychophysics*, 22(3), 293–302.
- & (2007). *Journal of Vision*, 7(2):9, 1–15, [://www.journalofvision.com/content/7/2/9](http://www.journalofvision.com/content/7/2/9), :10.1167/7.2.9.
- (2008). *Vision Research*, 48(5), 635–654.
- & (2002). *Journal of Vision*, 2(2):3, 167–177, [://www.journalofvision.com/content/2/2/3](http://www.journalofvision.com/content/2/2/3), :10.1167/2.2.3.
- (1987). & (), *Perspectives on Perception and Action*. 335–357.
- & (1981). *Memory & Cognition*, 9(1), 50–67.
- & (2001). *Natural Neuroscience*, 4(7), 739–744.
- & (2004).

Journal of Vision, 4(12):12, 1136–1169, doi:10.1167/4.12.12. (2004).
 Journal of Educational Psychology, 67(2), 301–306. (1975).
 Psychological Science, 17(3), 192–193. (2006).
 Journal of Vision, 5(11):8, 1024–1037, doi:10.1167/5.11.8. (2005).
 American Journal of Ophthalmology, 53, 471–477. (1992).
 Vision Research, 32(7), 1349–1357. (1992).
 Perception & Psychophysics, 10, 375–378. (1971).

Journal of Vision, 2(1):1, 1–11, doi:10.1167/2.1.1. (2002).
 Vision Research, 42(20), 2357–2369. (1987).
 Perspectives on Perception and Action. (1984).
 Memory & Cognition, 12, 458–469. (1984).
 Vision Research, 32(3), 513–526. (1992).
 Psychological Review, 82, 184–199. (1975).
 Investigative Ophthalmology & Visual Science, 48(5): 2383–2390, doi:10.1167/48/5/2383. (2007).
 Vision Research, 49(1), 44–53. (2009).