Notes and Comment

Illusions about the Poggendorff illusion: Comment on Poulton's "Geometric illusions in reading graphs"

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Not only are there visual illusions; there are also illusions about illusions. One of the most powerful of these is the assimilation to the Poggendorff illusion of other alignment illusions—API for short. In attributing a constant error in the reading of graphs to the Poggendorff illusion, Poulton (1985) has provided the latest example of the operation of the API tendency. In fact, the constant error that he observed is due to two other alignment illusions and not the Poggendorff. Poulton has, however, provided a new explanation for the appearance of these other illusions which apparently justifies their being regarded as instances of the Poggendorff illusion. Since this explanation, which faults certain earlier investigations on methodological grounds, seriously misrepresents them, my purpose is to show that it is a misrepresentation. To do this, I will first describe the four alignment illusions in question, second, indicate Poulton's argument, and third, show that it is unjustified.

Two of the four illusions are simple in that they show misalignment when the display is only a line and a dot, and two are complex in that a second line induces a further and more powerful misalignment of the line with the dot. I name the two simple alignment illusions the "horizontal/vertical assimilation tendency" (HVA) and the Zehender illusion, although the latter is widely, but (because of the operation of the API tendency) misleadingly, known as "the parallelless Poggendorff" or "Poggendorff without parallels." The two complex illusions are the Obonai and the Poggendorff illusions.

The HVA illusion. The HVA illusion is shown in the apparent tendency to see line segments as being nearer in orientation to the main spatial coordinate that they are closer to than they actually are. Thus, lines up to 45° to the horizontal are apparently seen as more horizontal than they are, and those more than 45° to the horizontal are apparently seen as more vertical.¹ Clearly, this was one of the illusions manifested in the constant errors shown in reading Poulton's graphs.

The Zehender illusion. One would expect from the HVA illusion that line segments midway between the horizon-

tal and vertical, that is, ones at 45° , should be correctly seen as aligned. This is, however, not so. They are seen as apparently more horizontal than they actually are. This was first noted by Wundt (1893) and first systematically studied by Zehender (1899). Today this illusion is widely described as a variant of the Poggendorff illusion. This is, however, incorrect because, when the conventional Poggendorff figure is presented with horizontal parallels, the 45° transversals are seen as misaligned in the opposite direction to the Zehender illusion, that is, as apparently more vertical than they actually are.

Poggendorff illusion. As Tong and Weintraub (1974) argued, "the prime requirement for the occurrence of a Poggendorff effect is the existence of an actual intersection between transversal and parallel" (p. 267). The difference between the Poggendorff and the Obonai illusions can conveniently be shown with simplified versions of the Poggendorff and Obonai figures. These are shown in Figure 1. In Figure 1a, the transversal is at an angle of 135° and in Figure 1b at one of 45° to the vertical line. Each transversal is aligned with an isolated target dot. Wenderoth and Johnson (1982, Experiments 1 and 3) have shown that with the display in Figure 1a the Poggendorff effect (transversal apparently seen as more horizontal) increases as the vertical line increases in length up to a certain amount, after which it remains the same, whereas with the display in Figure 1b, as the length of the transversal approaches that of the vertical line, a negative Poggendorff effect is found (transversal apparently more vertical), which gradually changes into a positive effect as the length of the vertical line exceeds that of the transversal.

Obonai illusion (Obonai, 1931). In Figures 1c and 1d, the isolated transversal is aligned with the target dots at the top and bottom, respectively, of the vertical line so as to form angles of 135° and 45° with it. I have shown (Hotopf, 1981, Experiments 7, 8, and 11) that when the transversal is at an angle of 135° with the vertical line

Figure 1. Simplified forms of the Poggendorff and Obonai illusions. The Poggendorff illusion (a) with the transversal at 135° , and (b) at 45° to the vertical induction line. The Obonai illusion (c) with the transversal at 135° and (d) at 45° to the vertical induction line.

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(Figure 1c) there is no significant misalignment at all, whereas when it is at 45° (Figure 1d) there is a misalignment in the same direction as the Poggendorff, which varies inversely with the length of the vertical line. Clearly, the relation between the angle formed by the transversal with the vertical line and the length of the vertical line, on the one hand, and direction and amount of misalignment, on the other, is quite different in the two illusions. It is also clear that the lines in Poulton's (1985) graphs, which are not contiguous with the horizontal and vertical lines of the abscissa and the ordinate, respectively, manifest not the Poggendorff, but the Obonai illusions (as well as the HVA tendency).

The fact that we can distinguish between these different alignment illusions does not, of course, mean that they may not co-occur in the same figure. The conventional Poggendorff figure, for example, may, depending upon the angle the transversal forms with the vertical parallels, be affected by either the HVA tendency or the Zehender illusion. In addition, there may be both an Obonai component, which is the effect upon the transversal of the vertical parallel that is distant from it, and a Poggendorff component from the parallel the transversal is contiguous to. Day and Kasperczyk (1985) have recently shown, although this is not their interpretation, that if the conventional Poggendorff figure is rotated through 45° so that the "transversals" are vertical and the parallel lines are at 45° to them, there is no Poggendorff but only an Obonai effect (Hotopf & Brown, 1985). It is, of course, the co-occurrence of these other illusions within the conventional Poggendorff figure that has led to their being dubbed as variants of the Poggendorff illusions. But there are probably many other illusions operating in the conventional Poggendorff figure (Hotopf, 1977), such as the Müller-Lyer and Piaget's rectangle illusion, but we would not for that reason think of calling them variants of the Poggendorff illusion.

To Poulton, however, none of the distinctions I have been making are of any validity. This, he claims, is because of unwanted asymmetrical transfer effects that may occur in the within-subjects designs of the experiments upon which these distinctions are based (Poulton, 1982; Poulton & Freeman, 1966). Specifically, the misalignment effects in the Zehender and Obonai illusions would have been "produced by transfer from prior judgments with a more complete Poggendorff figure" (Poulton, 1985, p. 543). By this he means the conventional Poggendorff figure with *vertical* parallels. To avoid this transfer, he recommends between-subjects designs for experiments and commends, in the field of visual illusions, Weintraub and Krantz (1971), because their first experiment on the Poggendorff illusion was based upon single observations from 850 subjects, and Warren and Bashford (1977), who did the same with 570 subjects in the Müller-Lyer illusion.

These unwanted transfer effects, however, need not take place—their effects, as he says, "range from large to negligible" (Poulton, 1982, p. 674; my italics). Indeed,

Poulton's second experiment on reading graphs did use a between-subjects design, but it was evidently considered to be free from bias due to unwanted transfer effects.

It is likely that any transfer effects that may have occurred in those of the experiments on the Zehender illusion that he quotes were also negligible, because two experiments, which he ignores, showed that the illusion occurred to a significant degree in displays that consisted only of two line segments lying in an orientation of 45° to the horizontal. There was no question in these experiments of transfer from prior judgments with a Poggendorff figure (Curthoys, Wenderoth, & Harris, 1975). Similarly, in my study of the Obonai illusion (Hotopf, 1981), I conducted nine experiments that determined the relation of the illusion to the length of the induction line, to the distance of the transversal from the target dot or line, and to the angle formed by the transversal with the induction line. In none of these experiments were the subjects required to make judgements about Poggendorff figures. Therefore, here too, there can have been no transfer effect. As for the HVA tendency, this also was studied with only two line segments by Bouma and Andriessen (1968) and no involvement of the Poggendorff figure. Indeed, transfer from the Poggendorff figure, conventionally displayed with vertical parallels, could scarcely account for misalignment due to assimilation to the *vertical*.

Poulton does, however, suggest one further factor that may be operating which enables him to account for the Zehender and Obonai illusions in terms of transfer from the Poggendorff. He suggests that an experiment of Day's (1973) which showed the Zehender effect and where the subjects were presented only with two line segments could be discounted because 4 of Day's 20 subjects had acted as subjects in an earlier experiment on the Poggendorff illusion. Their experience of the Poggendorff illusion, he suggests, could have been transferred to the Zehender so that they saw the latter in terms of the former. This, of course, very much extends the notion of what is meant by a between-subjects design. Any apparently within-subjects design may, in fact, due to the past history of the subject's participation in other experiments, be a concealed between-subjects study. As for the point at issue, I cannot speak for other investigators, but in the case of my own subjects, some were, it is true, familiar with the Poggendorff illusion, but others were not, and yet they showed the Obonai effect in their very first judgments of the displays. Indeed, the fact that the Obonai illusion, as outlined above, shows different characteristics from those of the Poggendorff indicates that transfer from the Poggendorff illusion, even in those familiar with it, cannot have been the explanation.

REFERENCES

- BOUMA, H., & ANDRIESSEN, J. J. (1968). Perceived orientation of isolated line segments. *Vision Research*, 8, 493-507.
- CURTHOYS, I., WENDEROTH, P., & HARRIS, J. (1975). The effects of the motion path and the length of the variable segment in the Poggen-

- dorff illusion without parallels. *Perception & Psychophysics*, **17**, 358-362.
- DAY, R. H. (1973). The oblique line illusion: The Poggendorff effect without parallels. *Quarterly Journal of Experimental Psychology*, **25**, 535-541.
- DAY, R. H., & KASPERCZYK, R. T. (1985). Apparent displacement of lines and dots in a parallel-line figure: A clue to the basis of the Poggendorff figure. *Perception & Psychophysics*, **38**, 74-80.
- FINDLAY, J. M., & HOTOPF, W. H. N. (in press). Eye movements and illusions of alignment. *Perception*.
- HOTOPF, W. H. N. (1977). An examination of Piaget's theory of perception. In B. A. Gerber (Ed.), *Piaget and knowing*. London: Routledge & Kegan Paul.
- HOTOPF, W. H. N. (1981). Mistracking in alignment illusions. *Journal of Experimental Psychology: Human Perception & Performance*, **7**, 1211-1246.
- HOTOPF, W. H. N., & BROWN, S. (1985). *Centre-of-gravity illusions and the visual salience of lines inducing the illusions*. Manuscript submitted for publication.
- OBONAI, T. (1931). Experimentelle Untersuchungen über den Aufbau des Sehraumes. *Archiv für die gesamte Psychologie*, **82**, 308-328.
- POULTON, E. C. (1982). Influential companions: Effects of one strategy on another in the within-subjects designs of cognitive psychology. *Psychological Bulletin*, **91**, 673-690.
- POULTON, E. C. (1985). Geometric illusions in reading graphs. *Perception & Psychophysics*, **37**, 543-548.
- POULTON, E. C., & FREEMAN, P. R. (1966). Unwanted asymmetrical transfer effects with balanced experimental designs. *Psychological Bulletin*, **66**, 1-8.
- TONG, L., & WEINTRAUB, D. J. (1974). Contour displacements and tracking errors: Probing 'twixt Poggendorff parallels. *Perception & Psychophysics*, **15**, 258-268.
- WARREN, R. M., & BASHFORD, J. A. (1977). Müller-Lyer illusions: Their origin in processes facilitating object recognition. *Perception*, **6**, 615-626.
- WEINTRAUB, D. J., & KRANTZ, D. H. (1971). The Poggendorff illusion: Amputations, rotations, and other perturbations. *Perception & Psychophysics*, **10**, 257-264.
- WENDEROTH, P., & JOHNSON, M. (1982). Visual illusions with acute and obtuse angles: Configurational effects and observer strategies. *Perception & Psychophysics*, **31**, 243-250.
- WUNDT, W. (1893). *Grundzüge der physiologischen Psychologie* (4th ed.). Leipzig: Engelmann.
- ZEHENDER, W. V. (1899). Über geometrisch-optische Täuschungen. *Zeitschrift für die Psychologie*, **20**, 65-117.

NOTE

1. I shall refer throughout to the lines as *apparently* being seen as more vertical or horizontal for convenience of exposition. However, they are not necessarily seen in this way. The alignment error could be due to a judgment based upon an eye movement or movement of attention that was biased in the direction of the misalignment (Findlay & Hotopf, in press; Hotopf, 1981; Hotopf, Hibberd, & Brown, in preparation).

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