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Letter to the Editor

Response to Wilson & Wilkinson: Evidence for global processing but no evidence for specialised detectors in the visual processing of Glass patterns

Wilson and co-workers (Wilson & Wilkinson, 1998; Wilson, Wilkinson, & Asaad, 1997) have reported lower signal-to-noise detection thresholds for rotational (concentric) compared to translational (parallel) Glass patterns. This they attribute to poor spatial summation within translations, which they went on to estimate by measuring thresholds as a function of the proportion of a stimulus occupied by a Glass pattern. These experiments led them to conclude that "parallel structure is only processed locally" (Wilson & Wilkinson, 1998) while rotations are processed by specialised concentric orientation detectors. However, we have recently shown that finding differences between rotational and translational Glass patterns is contingent on the use of a circular pattern-aperture, since the effect is abolished with square apertures or noise surrounds (Dakin & Bex, 2002). We suggested that this is because dipoles near the edge of circularly-apertured rotational Glass patterns are co-aligned with the aperture, creating additional "edge-smoothness" cues. When these cues are minimised we show similar patterns of global orientation integration for both types of pattern as a function of signal area (be it overall size, or percentage of a noise pattern occupied by signal).

Wilson and Wilkinson (2003) have misrepresented our final position as being that: "we find no psychophysical evidence for global concentric orientation summation in circular Glass patterns". This statement confuses two concepts we have been careful to keep separate: concentric orientation detectors, and global orientation summation. While Dakin and Bex (2002) state that this paradigm offers "no concrete psychophysical evidence for specialised concentric orientation detectors" (because of the edge artefact) we also unambiguously state that "we observe similar patterns of global integration for both rotational and translational patterns" and that "all subjects showed robust improvement in threshold with increasing stimulus area for both transformation types". [1]

The re-plotting of our data by Wilson and Wilkinson highlights the presence of global summation (which we both recognized and commented upon) but does not in itself support their original position because *summation is a necessary, but not sufficient condition for identifying specialized detectors*. Fig. 1 shows spatial summation thresholds from Wilson and co-workers (circles) and our paper (stars) for (a) rotations and (b) translations. A non-zero integration slope simply indicates *summation across space*, which could arise either from probability summation among multiple local detectors or from processing by a specialized detector; it does not necessarily implicate the latter. To counter the idea that integration slopes arise from simple probability summation, Wilson et al. (1997) compared performance with translational Glass patterns, and when they found differences in performance stated: "As concentric and parallel Glass patterns have highly similar *local* statistics, it may be concluded that linear summation in the former reflects a *global* orientation pooling process optimized for concentric patterns". Because translations are approximately matched to rotations in terms of their local orientation statistics a finding of selectively poor integration with translations argues against the proposition that spatial summation is inevitable since thresholds will tend to rise as signal-area decreases. Crucially, our data show that this difference in slope arises from a structural artefact at the edges of the stimuli. When this artefact is removed, summation indices are the same for both classes of stimuli. This observation is not challenged by Wilson and Wilkinson (2003).

Wilson and Wilkinson (2003) do speculate that if edge artefacts account for differences between rotational

[1] Indeed, one of us has previously formulated an ideal observer model for quantifying efficiency of global integration in texture (Dakin, 2001; Dakin & Watt, 1997) and Glass patterns (Dakin, 1999), and we are the authors of a recent publication about Glass patterns entitled "Local and global visual grouping: Tuning for spatial frequency and contrast" (Dakin & Bex, 2001). From this it seems unlikely we would have "missed the evidence" for global summation, when the evidence amounts to the fact that our summation functions have non-zero slopes (stars, Fig. 1).

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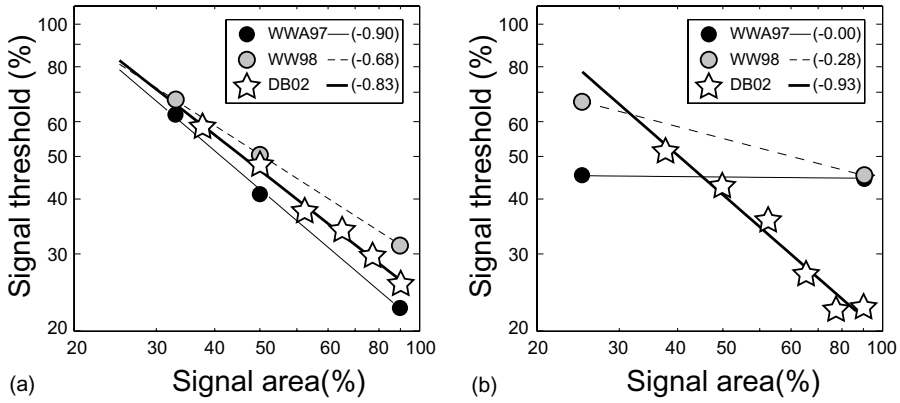

Fig. 1. Signal-to-noise detection thresholds for (a) rotational and (b) translational Glass patterns as a function of the proportion of the stimulus occupied by signal dots. Data points are averaged across four subjects for the two Wilson et al. studies (circles), and three subjects (two conditions for each) for our own study (stars). Lines are least-squares fits. We show similar patterns of summation for (a) rotational patterns and (b) translational patterns (average slopes of −0.90 and −0.93 respectively). In their letter Wilson and Wilkinson correctly point out the similarities between our and their data for (a) but neglect to point out the substantial discrepancies between our results with translations and their own (average slopes of 0.00 or −0.28 versus −0.93), as shown in (b).

and translational conditions then square-windowed translations should be better than round windowed, and while this is the case for one observer, it is not so for the other two subjects. However, a square windowed translational pattern contains only 63% $(2/\pi)$ as much of the edge artefact as the round windowed pattern because it is present on only two of the four sides. Furthermore every point but four on such a square boundary is more eccentric than the equivalent round boundary, and consequently will be less visible. These two factors taken together could explain why we did not observe an equivalent square-boundary artefact with translational patterns with all subjects.

In summary, we have shown that both rotational and translational Glass patterns show spatial summation. Our conservative view is that global integration is linked to the degree of *redundancy* in Glass patterns, or in other words the *predictability* of their orientation structure and that this is the same for translational and rotational Glass pattern. It remains to be seen if local-orientation predictability might not also account for the detection of structure in spiral Glass patterns, which elicit correspondingly higher thresholds than their rotational or radial components (Seu & Ferrera, 2001).

References

Dakin, S. C. (1999). Orientation variance as a quantifier of structure in texture. *Spatial Vision, 12*, 1–30.

Dakin, S. C. (2001). Information limit on the spatial integration of local orientation signals. *Journal of Optical Society of America A: Optics, Image Science and Vision, 18*, 1016–1026.

Dakin, S. C., & Bex, P. J. (2001). Local and global visual grouping: Tuning for spatial frequency and contrast. *Journal of Vision, 1*, 99–111.

Dakin, S. C., & Bex, P. J. (2002). Summation of concentric orientation structure: Seeing the Glass or the window? *Vision Research, 42*, 2013–2020.

Dakin, S. C., & Watt, R. J. (1997). The computation of orientation statistics from visual texture. *Vision Research, 37*, 3181–3192.

Seu, L., & Ferrera, V. P. (2001). Detection thresholds for spiral Glass patterns. *Vision Research, 41*, 3785–3790.

Wilson, H. R., & Wilkinson, F. (1998). Detection of global structure in Glass patterns: Implications for form vision. *Vision Research, 38*, 2933–2947.

Wilson, H. R., & Wilkinson, F. (2003). Further evidence for global orientation processing in circular Glass patterns. *Vision Research, 43*, 563–564.

Wilson, H. R., Wilkinson, F., & Asaad, W. (1997). Concentric orientation summation in human form vision. *Vision Research, 37*, 2325–2330.

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