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# Selective peripheral fading: evidence for inhibitory sensory effect of attention

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**Abstract.** A circular array of six discs, three green and three orange in alternate positions, was presented against a uniform grey background. Sixteen observers maintained steady fixation at the centre of the array, and were instructed to direct their attention to three discs of one colour and to ignore the three discs of the other colour. In about 10 s (mean = 11.35 s), some discs started to fade away from awareness. Of those starting to fade, most (mean = 81.3%) were those selected for attention. The faded discs remained out of awareness for up to a few seconds (mean = 1.55 s) during which other discs were clearly visible. The fading increased with eccentricity, a defining characteristic of Troxler fading. However, the selectivity of the fading strongly suggests that voluntary attention can have an inhibitory effect on early sensory processing. Were the fading entirely due to local sensory adaptation, the unattended stimuli would have to be equally adapted and yet somehow remain visible for seconds, which is not plausible.

## 1 Introduction

Attention can be directed voluntarily to an object in peripheral vision. If one keeps attending to the object (eg a yellow magnetic disc on a white board) for a few seconds, the image will become fainter or disappear from awareness. This illusion, known as Troxler fading (Troxler 1804), is commonly considered a form of sensory adaptation, caused by overestimulation or fatigue of receptors or neurons (cf Ramachandran 1992). It can be observed most readily when the luminance of the object is close to that of the background (Livingstone and Hubel 1987).

When I was drawing a display composed of simple superimposed line drawings for another study, I observed that fragments of the line drawings frequently faded from my awareness. Surprisingly, the part that I paid close attention to often seemed to fade earlier, leaving the rest of the drawing visible in the background. Several colleagues and postgraduate students confirmed this observation, with many variants of the display. More than an effect of sensory adaptation, the fading appears to be facilitated by voluntary attention.

As is often the case in vision research, the finding turned out to be not entirely new. Babington-Smith (1961) reported a very similar observation:

> "Arrange a number of small objects such as keys, coins etc., on a table and fixate a point among them from some convenient distance, say 3 ft. Maintain fixation of the point selected, attend to one of the objects and try to see or describe it in detail.... The object selected for attention becomes hazy and may even disappear. The effect may persist for seconds at a time or it may be fleeting or fluctuating; but other objects in the field remain steadily visible meantime."

Babington-Smith offered no explicit explanation for this observation except to suggest that it may have to do with "central interference". In light of its potentially important implication for theories of visual selective attention, it is surprising Babington-Smith's observation was not followed up in the last 38 years. To some, the concept of attention used for the description of the phenomenon (henceforth, selective peripheral fading, or SPF) may appear too subjective.

In these observations, attention amounts to observers' effort to perceive a display in a way conforming to the instruction. It is verifiable to the extent that observers can tell which part of the display they perceive as figure and which part they perceive as ground. This approach was advanced by Hochberg and Peterson (eg Hochberg 1981; Hochberg and Peterson 1993; Peterson 1986). For example, Peterson (1986) showed that, by voluntarily 'holding' attention to a designated depth in a stereogram, observers could control the direction of an illusory concomitant motion in depth. Such phenomena demonstrate that motivation and voluntary attention can affect perceptual processes.

Similarly, SPF can be considered a 'perceptual coupling' of voluntary attention in the sense of an instruction-conforming figure–ground construal (Hochberg 1981). As such, it may reflect an inhibitory effect of voluntary attention on sensory processes. Alternatively, SPF may be explained by a postsensorial bias of attention, wherein sensory adaptation (neural fatigue) occurs to the attended and unattended parts of a display alike, but only the adaptation of the attended part enters awareness. The latter explanation entails that the report of seeing the unattended part when the attended part is fading has no sensory basis, but reflects the belief of the observer. To test this possibility, controlled observations (experiments) are needed to determine the extent to which the fading is confined to the attended part. If, for example, the attended part disappears from awareness for about 10 s and the unattended part remains visible meantime, the remaining visibility could hardly be attributed to a failure to report, or be aware of, the fading that actually occurs. In practice, a less strong case might be sufficient for rejecting the postsensorial bias as a plausible explanation.

## 2 Experimental methods

The display illustrated in figure 1 was used in the experiment. It consists of a circular array of six discs, three green and three orange ones in alternate positions against a uniform grey background. This design was intended to optimise the condition for finding an inhibitory effect of attention on visual sensory processes. Thus, using spatially discrete discs instead of line drawings was expected to increase the accuracy in measuring the extent of the fading. The spatial layout of the discs ensures that when the fixation drifts from its designated position, one set of discs (eg the green ones) will not be displaced to more peripheral locations than the other set (eg the orange ones). The green and orange colours were chosen for the discs because they serve as perceptually distinct cues for selective attention, and their luminance contrasts with the background were low enough for the peripheral fading to occur easily while leaving room for its modulation by attention. Last, attended and unattended discs were arranged in spatially close pairs to facilitate the awareness of any fading occurring to the unattended discs, thereby making it implausible to attribute the absence of such fading to a postsensorial bias of attention.

Eighteen undergraduate students of the University of Hong Kong served as observers. All of them reported having normal vision. Their participation earned them partial credit for an introductory psychology course. The experiment was controlled by a 486 PC with a 21-inch colour monitor for the display. The viewing distance was kept at 35 cm with observers' chin and forehead supported. Observers were told to fixate the centre of the display marked by the cross and at the same time try to maintain attention to either the green or the orange discs by following instructions. To facilitate this task, they were told to try to perceive the three discs as forming an equilateral triangle. For the first few trials they were asked to report anything 'unusual' that they observed. A few of them spontaneously reported that some discs in the display disappeared from awareness after a few seconds of viewing. Most of them were initially unsure what to report. Upon the more specific question "Are you constantly aware of the six discs?", they reported that some discs appeared to fade and then reappear. They were subsequently asked "Which of them faded first?" and given a few more trials. In most cases, the discs that faded first

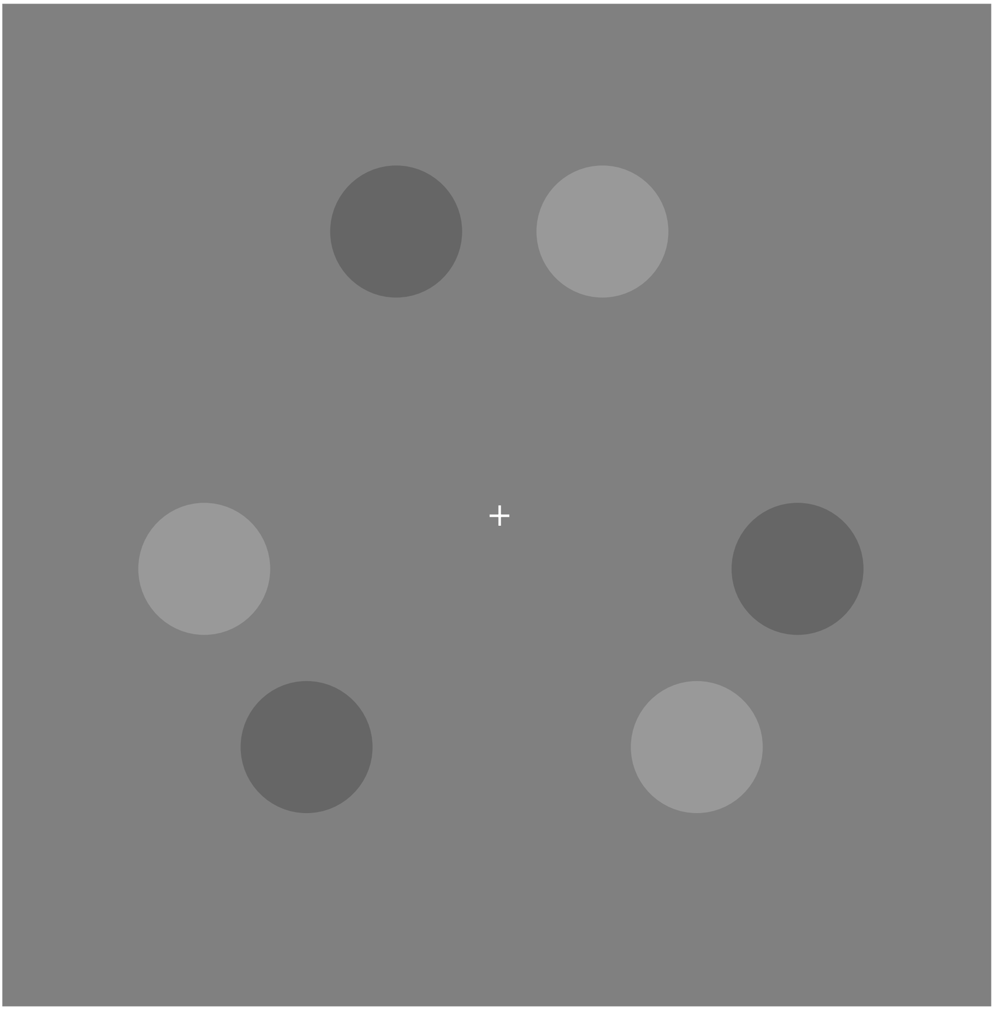

**Figure 1.** The display used for the experiment. The light discs were green, the dark discs were orange. At 35 cm viewing distance, the disc eccentricity, ie the visual angle between the disc centre and the fixation point, was 11.3 deg for the largest display (blocks 1 and 2), and 4.4, 2.2, 1.0, and 0.8 deg for the smaller displays, with disc sizes proportionally reduced (blocks 3 – 6, in random order). The colour stimulus can be seen on the *Perception* web site at http://www.perceptionweb.com/perc0499/lou.html.

were those attended. Observers often expressed surprise over the fading phenomenon, especially the fact that it occurred to stimuli that they paid close attention to. Two of them failed to observe any fading of the discs after numerous attempts.

Those who observed fading were further tested. They were instructed to press a key as soon as at least one disc disappeared from awareness, and keep the key pressed until at least one of them reappeared. In cases where further discs faded before those that faded first had recovered, they were told to press a second key to signal the fading that occurred later. The display was presented for a maximum of 40 s, after which observers were asked to recall how many discs of each colour disappeared from awareness when the first key was pressed. The manual responses and the recall provided information about the onset latency, duration, selectivity, and extent (number of faded discs) of the fading that occurred first. The subsequent episodes of fading were not recorded because the role of voluntary attention in them could not be specified.

The experiment had two parts. The first and main part consisted of two blocks of seven trials each. Observers were instructed to attend to green discs in the first block and to orange ones in the second block, or vice versa, with the order counterbalanced between observers. Randomly assigned to the seven-trial sequence of each block were two 'catch' trials, on which two discs, one of them in the attended colour, physically disappeared with a latency of 3–4 s, which should have been long enough for attention to engage the designated discs. It was thought that if the selective fading is caused by a postsensorial bias, ie the bias that reflects observers' inability to be aware of the sensory absence of the unattended discs, they might likewise fail, or be slower, to notice the physical offset of the unattended disc alongside that of the attended disc.(1)

The second part of the experiment was designed to assess to what extent the fading is a phenomenon in peripheral vision. For that purpose, the same display was used in blocks 3–6, with its size reduced in various proportions across the blocks. Because the specific disc colour attended would seem inessential for demonstrating the direction in which the fading effect changes with eccentricity, observers were instructed to attend to the same colour (green) throughout these blocks. The catch trials were not included for similar reasons, leaving five trials for each block.

Because staring at a display continuously is a tiring task, the experiment was conducted at a slow pace, leaving sufficient time for eyes to recover. Moreover, the display was rotated from trial to trial in random multiples of 40° in order to alleviate possible effects of negative afterimages from the previous trial. Observers were encouraged to report if they felt they had a lapse of attention during a trial. Whenever they did, the trial was redone.

## 3 Results

In the first two blocks, none of the observers failed to detect the simultaneous physical offset of the attended and unattended discs. Consequently, the catch trials were considered not diagnostic for a potential postsensorial bias of attention (cf footnote 1) and were not analysed further. For the rest of the two blocks, perceptual fading of at least one disc was reported on all trials except three, each of which was with a different observer and when orange discs were designated for attention. Four different aspects of the fading (table 1) were analysed: selectivity (the proportion of the attended discs among the faded ones), onset latency, duration of unawareness, and the extent (the number of discs observed to fade simultaneously). The selectivity of fading was the defining measure of SPF. According to whether attention was directed to the green or orange discs, the attended discs constituted 94.58% (95% confidence interval = 11.28%) and 68.02% (95% confidence interval = 16.16%), respectively, of the discs that faded first. In both cases, the proportions were significantly higher than chance (50%). In particular, for five observers, the fading was so selective that only the attended discs faded on any trial.

Except for one of all trials across observers, when the faded discs were of the same colour, only one key was pressed, which means that by the time these discs had reappeared in awareness the discs of the other colour remained visible. On average, the discs started to fade from awareness 11.35 s (95% confidence interval = 2.84 s) after the onset of the display, and the absence of awareness lasted 1.55 s (95% confidence interval = 0.49 s), which involved 1.46 discs (95% confidence interval = 0.20). The onset latency and the number of faded discs did not seem to vary much with the colour selected for attention. The duration of the unawareness was longer when attention was directed to the green discs (1.88 s) than to the orange discs [1.23 s; $t_{15} = 3.80$ (one-tailed); $p < 0.005$].

(1) On reflection, this comparison may be unfair because, unlike the fading of visual awareness, the physical offset of a previously unattended stimulus could catch attention. If the disappearance of the stimulus went unnoticed, a postsensorial bias of attention in the SPF would have been highly likely. But a failure to obtain such a result could not be taken to suggest the opposite.

**Table 1.** The means of four dependent measures of fading from the first two blocks, catch trials excluded. Green: green discs were selected for attention; orange: orange discs were selected for attention. The numbers in parentheses are standard errors.

| Observer | Attended discs/% | | Onset latency/s | |
|---|---|---|---|---|
| | green | orange | green | orange |
| 1 | 83.33 (10.54) | 43.33 (4.08) | 6.12 (0.89) | 5.23 (0.47) |
| 2 | 100.00 (0.00) | 100.00 (0.00) | 10.90 (1.92) | 8.47 (0.82) |
| 3 | 100.00 (0.00) | 50.00 (22.36) | 9.20 (0.94) | 8.71 (0.55) |
| 4 | 60.00 (18.70) | 90.00 (10.00) | 10.00 (1.38) | 8.71 (0.78) |
| 5 | 100.00 (0.00) | 100.00 (0.00) | 5.03 (0.50) | 9.26 (1.20) |
| 6 | 100.00 (0.00) | 53.33 (22.61) | 8.27 (1.00) | 9.90 (2.93) |
| 7 | 90.00 (10.00) | 50.00 (22.36) | 8.38 (1.13) | 12.07 (1.72) |
| 8 | 100.00 (0.00) | 100.00 (0.00) | 27.91 (6.81) | 17.19 (2.30) |
| 9 | 100.00 (0.00) | 40.00 (18.71) | 14.87 (2.05) | 18.58 (3.56) |
| 10 | 100.00 (0.00) | 50.00 (22.36) | 8.99 (2.00) | 6.60 (0.55) |
| 11 | 80.00 (12.25) | 46.67 (16.16) | 9.10 (1.22) | 6.73 (0.89) |
| 12 | 100.00 (0.00) | 100.00 (0.00) | 20.48 (3.91) | 25.71 (5.50) |
| 13 | 100.00 (0.00) | 0.00 (0.00) | 6.90 (0.78) | 4.69 (0.89) |
| 14 | 100.00 (0.00) | 90.00 (10.00) | 12.30 (3.33) | 12.24 (1.60) |
| 15 | 100.00 (0.00) | 100.00 (0.00) | 12.45 (2.60) | 9.45 (2.11) |
| 16 | 100.00 (0.00) | 75.00 (25.00) | 12.18 (3.51) | 16.58 (3.64) |
| Mean | 94.58 (2.82) | 68.02 (7.58) | 11.44 (1.44) | 11.26 (1.41) |
| | Duration/s | | Number of discs | |
| | green | orange | green | orange |
| 1 | 2.13 (0.80) | 0.72 (0.10) | 2.17 (0.31) | 2.40 (0.24) |
| 2 | 1.30 (0.38) | 1.26 (0.20) | 1.20 (0.20) | 1.40 (0.24) |
| 3 | 1.20 (0.26) | 1.14 (0.22) | 1.60 (0.24) | 1.20 (0.20) |
| 4 | 1.45 (0.24) | 0.89 (0.19) | 1.60 (0.24) | 1.60 (0.60) |
| 5 | 1.03 (0.14) | 0.47 (0.03) | 1.40 (0.24) | 1.20 (0.20) |
| 6 | 1.44 (0.17) | 1.11 (0.21) | 1.40 (0.24) | 1.40 (0.40) |
| 7 | 1.18 (0.22) | 3.47 (1.94) | 1.40 (0.24) | 1.20 (0.20) |
| 8 | 4.31 (0.45) | 2.80 (0.11) | 1.80 (0.20) | 1.60 (0.24) |
| 9 | 5.24 (1.98) | 2.88 (0.68) | 1.80 (0.37) | 1.80 (0.37) |
| 10 | 1.09 (0.10) | 1.04 (0.15) | 1.00 (0.00) | 1.20 (0.20) |
| 11 | 1.90 (0.32) | 0.87 (0.21) | 2.00 (0.55) | 1.80 (0.37) |
| 12 | 1.91 (0.35) | 1.18 (0.16) | 1.00 (0.00) | 1.00 (0.00) |
| 13 | 2.05 (0.20) | 1.09 (0.23) | 1.00 (0.00) | 1.00 (0.00) |
| 14 | 0.98 (0.18) | 0.80 (0.03) | 1.20 (0.20) | 1.40 (0.24) |
| 15 | 1.47 (0.21) | 1.18 (0.07) | 2.20 (0.20) | 1.60 (0.40) |
| 16 | 1.35 (0.20) | 0.81 (0.17) | 1.20 (0.20) | 1.00 (0.00) |
| Mean | 1.88 (0.30) | 1.23 (0.22) | 1.50 (0.10) | 1.43 (0.09) |

Figure 2 shows how disc eccentricity affected the fading. There was a dramatic drop of the frequency of fading with reduced eccentricity, eg from 86.25% (95% confidence interval = 16.38%) at 4.4 deg to 27.50% (95% confidence interval = 23.3%) at 0.8 deg (figure 2a). Note that because of the inevitable fixation shift, the percentage of fading was probably inflated at smaller eccentricities, which means that the actual decrease of fading might be even more dramatic. At the smaller eccentricities, it remains that mostly the attended discs faded first (figure 2c). However, the fading tended to occur with longer latency (figure 2b), to recover more quickly (figure 2d), and become less extensive (figure 2e). These characteristics suggest that, like the Troxler fading, SPF is largely a phenomenon of peripheral vision.

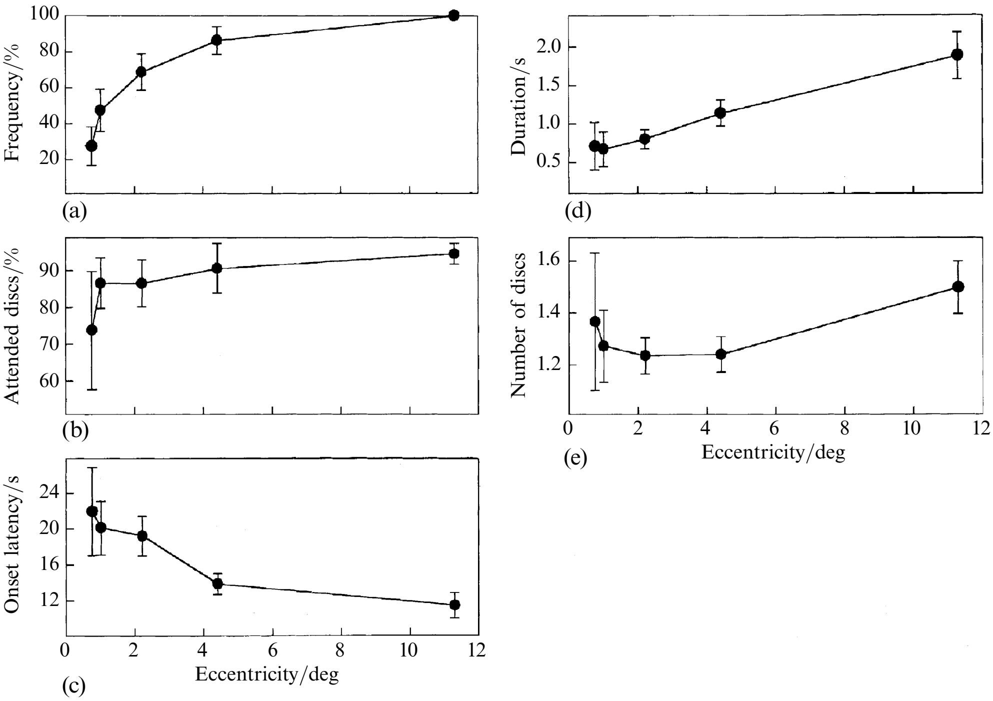


**Figure 2.** The effect of eccentricity on fading of discs: (a) frequency, (b) selectivity, (c) onset latency, (d) duration, and (e) extent of fading.

## 4 Discussion

### 4.1 *The selective fading of attended stimuli*

Although the green discs faded more frequently than the orange ones, the manipulation of attention clearly had an effect on fading: regardless of their specific colour, the discs faded more frequently as an attended figure than as part of the background. Most persuasively, for five subjects only the attended discs ever faded. Moreover, by the time these faded discs reappeared in awareness about 1.5 s later, the unattended discs remained visible. The evidence was highly consistent across observers.

During the 11 s or so before the fading was observed, fixation shifts or saccades would have been inevitable, despite the observers' best effort to maintain steady fixation. Indeed, such eye movement was recorded by Gerrits et al (1984) under similar experimental conditions. However, because each set of the three discs constitutes an imaginary equilateral triangle and is located on the same circle centred on the fixation as the other set, it is virtually impossible for one set to be displaced into more peripheral vision than the other because of eye movement. Moreover, assuming that the earliest fading occurs to the disc farthest from the fixation would remain problematic for explaining why the attended one fades earlier. From any point in the display, there is a pair of discs, one attended and the other not, that are farther away than the other two pairs, but there is not much difference in how far the two member discs are from that point. Therefore, the selective fading has to be credited somehow to covert attention.

### 4.2 *Inhibitory sensory effect of attention*

The selective fading may reflect an inhibitory sensory effect of attention on sensory processes or a postsensorial bias of attention. However, in the face of the high selectivity found of the fading, the hypothesis of postsensorial bias does not seem tenable. In particular, it seems impossible that an unattended disc would remain visible for 1.5 s or longer after sensory adaptation has occurred to all the discs, unless the retained awareness were something akin to visual hallucination, or the phantom vision reported by some patients with an impaired visual system (Melzack 1992). The experimental setting was also very different from those that induce 'inattentional blindness' (Mack and Rock 1998), where, for example, a display contains an item that viewers are not informed of, and from which they are deliberately distracted by a secondary task. It is not surprising to find, in the latter case, that subjects fail to perceive the item, or the absence of it following its regular appearances. In contrast, it is reasonable to assume that the unattended discs in this experiment were visible as part of the background, and that observers were motivated to report the disappearance of any disc in the display. That they failed to do so should then be taken as indicating the absence of sensory adaptation to the unattended discs.

Furthermore, if one assumes a gradual decay of spatial attention (Downing and Pinker 1985) from its focus, any inhibitory postsensorial bias towards the unattended discs due to lack of attention would be minimal given that the unattended discs were close to the attended ones. In other words, the spatial proximity should have facilitated the awareness of any fading of the unattended discs. Because even this favourable condition did not lead observers to be consistently aware of any fading of the unattended discs alongside that of the attended ones, it becomes most likely that the fading resulted from a sensory inhibition that occurred selectively to the attended discs.

### 4.3 *Implications*

SPF is apparently relevant to a recurrent debate concerning the role of attention in perception. According to some early-selection models (Broadbent 1958; Treisman 1969), attention functions like a filter or attenuator in the early sensory or perceptual processes, resulting in only a subset of stimuli (the attended ones) being perceived. Standing in contrast are the late-selection views of attention (eg Deutsch and Deutsch 1963; Prinzmetal et al 1997), according to which all stimuli undergo full perceptual processing, and the effect of attention is in biasing or prioritising the perceptual information for conscious access. With regard to this debate, SPF seems to support the early-selection views by showing that attention can modulate brightness and colour boundaries in a dramatic and somewhat counterintuitive way.

In particular, considering SPF as an instance of the Troxler fading provides clues as to where in the visual pathways attention might expedite the fading. Most previous studies suggested that Troxler fading occurs in early visual pathways, notably the LGN (Clarke and Belcher 1962), or even retinal ganglion cells (Kotulak and Schor 1986; Millodot 1967). Consequently, it is possible that SPF results from the sensory adaptation in early visual pathways being expedited by a top–down process. Alternatively, two separate processes may contribute to SPF: the sensory adaptation that occurs in early visual pathways and an adaptation that occurs at the cortical areas associated with selective attention and/or visual awareness. In both scenarios, the attentional modulation would seem to occur earlier than suggested by some influential early-selection theories of attention. For example, in Treisman's feature-integration theory (Treisman and Gelade 1980), attention serves to bind individual features into objects, whereas the attentional modulation on brightness and colour boundaries seems to be at feature level.[2]

As an inhibitory effect, SPF contradicts the common assumption that attention enhances perception. However, it may be understood by considering the conditions under which the effect was obtained. The conditions were those known to be conducive to perceptual fading—prolonged steady fixation (MacKinnon et al 1969), peripheral stimulus

[2] As SPF occurs only after a prolonged period of viewing, it is possible that attention initially serves to integrate individual features into objects, but can subsequently penetrate to the input end and modulate the sensory processes necessary for maintaining the percept of the object.

location (Troxler 1804), and minimal luminance contrast between the stimulus and its background (Livingstone and Hubel 1987). They seem to be associated with a liability of the perceptual channels or circuits involved. Thus, steady fixation may lead to perceptual fading through a built-in self-inhibitory input circuit (Cornsweet 1970), which normally serves to orient organisms to novel stimuli. The smaller retinal ganglion and cortical magnification (Myerson et al 1977) at peripheral vision, especially for the peripheral stimuli contrasting in colour only with the background, may further contribute to the fading. To explain SPF, these conditions may be assumed to facilitate adaptation of not only the ascending sensory activation but also the descending activation of voluntary attention.

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**References**

Babington-Smith B, 1961 "An unexpected effect of attention in peripheral vision" *Nature (London)* **189** 776
Broadbent D E, 1958 *Perception and Communication* (Oxford: Pergamon Press)
Clarke F J J, Belcher S J, 1962 "On the localization of Troxler's effect in the visual pathway" *Vision Research* **2** 53 – 68
Cornsweet T N, 1970 *Visual Perception* (New York: Academic Press)
Deutsch J, Deutsch D, 1963 "Attention: Some theoretical considerations" *Psychological Review* **70** 80 – 90
Downing C J, Pinker S, 1985 "The spatial structure of visual attention", in *Attention and Performance XI* Eds M I Posner, O S M Marin (Hillsdale, NJ: Lawrence Erlbaum Associates) pp 171 – 187
Gerrits H J M, Stassen H P W, Erning L J T O van, 1984 "The role of drifts and saccades for the preservation of brightness perception", in *Sensory Experience Adaptation and Perception* Eds L Spillman, B R Wooten (London: Lawrence Erlbaum Associates) pp 439 – 459
Hochberg J, 1981 "On cognition in perception: Perceptual coupling and unconscious inference" *Cognition* **10** 127 – 134
Hochberg J, Peterson M, 1993 "Mental representations of occluded objects: Sequential disclosure and intentional construal" *Giornale Italiano di Psicologia* **20** 805 – 820
Kotulak J C, Schor C M, 1986 "The accommodative response to subthreshold blur and to perceptual fading during the Troxler phenomenon" *Perception* **15** 7 – 15
Livingstone M S, Hubel D H, 1987 "Psychophysical evidence for separate channels for the perception of form, color, movement, and depth" *Journal of Neuroscience* **7** 3416 – 3468
Mack A, Rock I, 1998 *Inattentional Blindness* (Cambridge, MA: MIT Press)
MacKinnon G E, Forde J, Piggins D J, 1969 "Stabilized images, steadily fixated figures, and prolonged after-images" *Canadian Journal of Psychology* **23** 184 – 195
Melzack R, 1992 "Phantom limbs" *Scientific American* **266**(4) 90 – 96
Millodot M, 1967 "Extra foveal variations of the phenomenon of Troxler" *Psychologie Française* **12** 190 – 196
Myerson J, Manis P B, Miezin F M, Allman J M, 1977 "Magnification in striate cortex and retinal ganglion cell layer of owl monkey: A quantitative comparison" *Science* **198** 855 – 857
Peterson M, 1986 "Illusory concomitant motion in ambiguous stereograms: Evidence for nonstimulus contributions to perceptual organization" *Journal of Experimental Psychology: Human Perception and Performance* **12** 50 – 60
Prinzmetal W, Nwachuku I, Bodanski L, Blumenfeld L, Shimizu N, 1997 "The phenomenology of attention. 2. Brightness and contrast" *Consciousness and Cognition* **6** 372 – 412
Ramachandran V, 1992 "Blind spots" *Scientific American* **266**(5) 44 – 49
Treisman A, 1969 "Strategies and models of selective attention" *Psychological Review* **76** 282 – 299
Treisman A, Gelade G, 1980 "A feature integration theory of attention" *Cognitive Psychology* **14** 107 – 141
Troxler D, 1804 "Uber das Verschwindern gegebener Gegenstande innerhalb unsers Gesichtskreises", in *Ophthalmologisches Bibliothek* Eds K Himly, J A Schmidt (Jena: Fromman) pp 51 – 53