Psychological Medicine, 1989, **19**, 875–885
Printed in Great Britain

The role of provocative visual stimuli in agoraphobia

FRASER N. WATTS[1] AND ARNOLD J. WILKINS
From the MRC Applied Psychology Unit, Cambridge

SYNOPSIS Three studies examine the role that provocative visual stimuli have in eliciting anxiety reactions in people with agoraphobia. Such stimuli elicit more anxiety in agoraphobic patients than control subjects. The effect of visual stimulation appears to be specific: (1) non-visual stimulation is without comparable effect; (2) both control and agoraphobic groups show similar effects of visual stimulation on another reaction such as headache. The anxiety effects of visual stimuli are correlated with the extent to which subjects experience depersonalization and somatic symptoms of agoraphobia, but not correlated with depression or the behavioural or cognitive aspects of agoraphobia. Alternative accounts of the possible role of visual stimulation in the anxiety reactions of agoraphobic patients are discussed.

INTRODUCTION

In the course of clinical work, we have been impressed that a substantial number of people with agoraphobia report that certain visual stimuli such as fluorescent light increase anxiety and can sometimes trigger panic attacks. The visual stimuli involved are broadly similar to those capable of inducing headaches in patients with migraine and seizures in those with photosensitive epilepsy, and will therefore be referred to here as *provocative* visual stimuli. The effects of such stimuli do not appear to have been explored systematically in agoraphobia. We report here, as a preliminary step, an investigation based on a self-report questionnaire of anxiety reactions of agoraphobic patients in response to provocative visual stimuli.

Wilkins *et al.* (1984) used a striped pattern with characteristics close to those for which headaches, eye-strain and seizures are maximally likely, a pattern we will refer to as the provocative pattern (see Fig. 1). There is a tendency for normal subjects to see illusions in response to this figure (e.g. colours, shimmering, etc.), and it can induce epileptiform EEG abnormalities in patients with photosensitive epilepsy. Clinical observations of agoraphobic patients indicate that this pattern is also capable of inducing somatic symptoms prodromal to panic. We therefore wished to investigate the visual responses of agoraphobic subjects.

Our experimental approach is partly modelled on previous work with normal subjects and patients with headaches. Normal subjects show significant correlations between the incidence of headaches and the number of illusions seen in response to the epileptogenic pattern (e.g. Nulty *et al.* 1987), the illusions accounting for about 20% of the variance in the frequency of headaches (Wilkins *et al.* 1984). Illusions in response to a 'control' pattern with wider stripes did not correlate with headaches, nor did illusions in response to the epileptogenic pattern correlate with other complaints, thus confirming the specificity of the relationship. Further, people with consistently unilateral headaches tend to report asymmetric illusions. Despite these impressive similarities in the visual triggering of headaches and epileptiform reactions, it is not claimed that the mechanisms are identical. For example, the temporal organization of stimulation may be important in the induction of epileptic seizures, but not in other non-epileptic reactions (Wilkins, 1986).

Similarly, even if it is confirmed that stressful visual stimuli are relevant to the anxiety reactions of agoraphobics, the mechanisms would not necessarily be exactly those involved in either photosensitive epilepsy or migrainous headaches. However, it might be expected that illusional responses to the epileptogenic pattern will be correlated with anxiety reactions in

[1]Address for correspondence: Drs F. N. Watts and Arnold Wilkins, MRC Applied Psychology Unit, 15 Chaucer Road, Cambridge, CB2 2EF.

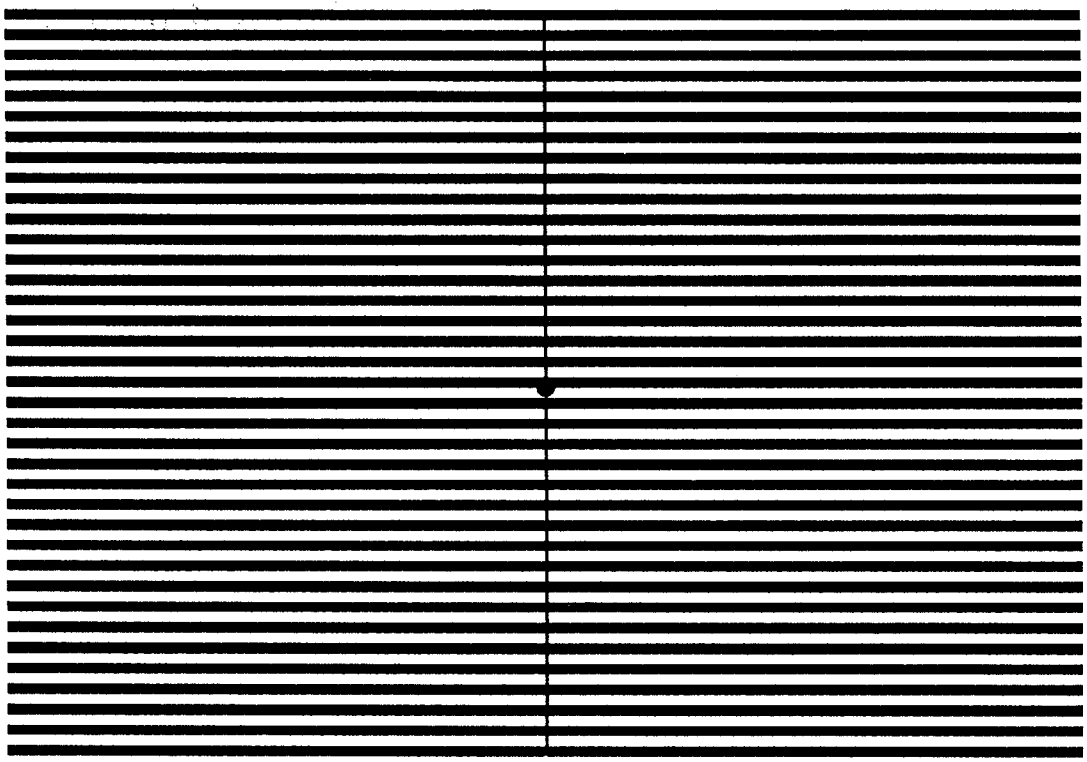

FIG. 1. A portion of the epileptogenic pattern. (The full pattern was circular with a diameter of 20 cm.)

agoraphobic patients. Anxiety is a multi-faceted phenomenon, and it has frequently been observed that behavioural, somatic and verbal/cognitive response dimensions are relatively independent of each other (e.g. Foa *et al.* 1984). Since the illusions test is sensitive to a physiological mechanism that might be involved in anxiety reactions, it might be expected that somatic aspects of anxiety in agoraphobics would correlate with response to the epileptogenic pattern more strongly than would cognitive or behavioural aspects. Though agoraphobic patients are often depressed, we would have no basis for predicting that this would be correlated with responses to the epileptogenic pattern, but we included a depression scale to test for the specificity of the hypothesized correlations.

Some years ago Roth and Harper (Harper & Roth, 1962; Roth & Harper, 1962) postulated a 'phobic anxiety-depersonalization syndrome' (PADS), though the explanation of depersonalization and its status as a syndrome remain controversial (e.g. Sedman, 1970; Weckowitz, 1970). In terms of the categories of the DSM-III many such patients would probably be classified as having 'agoraphobia', or, if phobic features were absent as having 'panic disorder' or 'generalized anxiety disorder'. Though there is fairly general agreement about the syndrome of dysfunctions to which agoraphobia refers, it is not a satisfactory term because it over-emphasizes similarities with simpler phobic disorders and under-emphasizes such problems as depersonalization and dizziness (Hallam, 1978, 1985). Bendikt's (1870) neglected term 'Planschwindel' (dizziness in public places) is preferable from this point of view. The concept of PADS has a similar heuristic value in emphasizing non-phobic aspects of the dysfunctions of agoraphobic patients. Nevertheless, the term 'agoraphobia' is so widely accepted that we will use it here to identify the people investigated.

A particularly interesting aspect of the concept of PADS, as presented by Roth and Harper, was

their discussion of the similarities and dissimilarities between PADS and temporal lobe epilepsy (TLE). Although Mayer-Gross (1935) and Shorvon *et al.* (1946) had already noted points of similarity, the differences that Roth and Harper found between PADS and TLE are so numerous and marked that there is no doubt whatever that the two disorders need to be distinguished. Nevertheless, the similarities between PADS and epilepsy conditions are intriguing and are still under-investigated. Harper and Roth focus mainly on the similarities in the phenomenal experiences of the two groups. Depersonalization, *déjà vu* experiences, metamorphosia and hallucinations are prominent characteristics of both groups. Also, paroxysmal attacks of fear and disturbances of consciousness are found in both conditions, even though fear is predominant in PADS, and disruption of consciousness predominant in epilepsy. Our primary focus here will be on the possibility that the visual stimuli that can contribute to seizures in some epileptic patients may also contribute to anxiety reactions in those with agoraphobia. Because of the role of depersonalization in Roth's formulation, we will be particularly interested to examine the relationship between visual sensitivity and depersonalization in agoraphobia.

INITIAL STUDY

Subjects

An advertisement was placed in the newsletter of the Phobic Society asking for assistance from people with agoraphobia. This method of recruiting subjects is clearly likely to produce a heterogeneous sample, and we do not wish to claim that all those who responded would necessarily meet the criteria for a clinical diagnosis of agoraphobia. However, our methodology does not require us to assume this; indeed the testing of correlational hypotheses benefits from having a fairly heterogeneous sample with appreciable variance in the measures being investigated. However, a number of responders who were clearly not agoraphobic were excluded, and 100 were selected for the initial study, which was conducted by mail. Data were obtained for 84 subjects.

Method

To assess agoraphobic status, subjects were asked to rate the extent of their avoidance behaviour on the 25 situations of the cumulative scale of Johnston *et al.* (1984). Each item was scored 0–4, thus yielding a total score ranging from 0 to 100. The range was 23–95 and the mean 76. Two comparable rating scales were devised to measure, respectively, 14 common worries of agoraphobics and 17 common somatic symptoms. These scales are very similar in content to the agoraphobic cognitions questionnaire and body sensations questionnaire of Chambless *et al.* (1984), though they were developed before the latter were published.

A brief questionnaire was constructed to assess the role of provocative visual stimuli in inducing anxiety reactions in agoraphobia. Eight forms of visual stimulation were listed (bright light indoors, watching television, sunlight reflected in water, glare, strip lights, very bright sunshine, sunlight broken up by trees or railings, and reading). Subjects were asked to rate each on a 4-point scale (very much, somewhat, slightly, not at all) according to whether it tended to bring on anxiety or make it worse.

Subjects were also assessed on a number of variables expected to correlate with sensitivity to stressful visual stimulation:

(*a*) The number of illusions from a checklist of 10 – Red, Orange, Green, Blue, Yellow, Blurring, Bending of Stripes, Shimmering, Flickering, Shadowy Shapes – reported in response to a narrow grating. The grating had a square-wave luminous profile, a Michelson contrast of 0·7, and spatial frequency of 4 cycles/cm. It was circular in outline with a diameter of 20 cm. Subjects were requested to fixate a central dot for 5 seconds, at a distance of 40 cm, with the curtains drawn and the room lights turned on.

(*b*) Headache reports, concerning the number experienced in the last 12 months, the length of time the worst headaches lasted, and a rating of the severity of the worst headaches on a four-point scale (noticeable but not distracting, fairly distracting, so severe you have to rest, almost unbearable).

(*c*) 'Depersonalization' assessed by Yes/No responses to the twelve-items in Dixon's (1963) scale.

Depression was assessed by the Carroll rating scale (Carroll *et al.* 1981), a self-report version of the widely used Hamilton scale (Hamilton, 1960).

Table 1. *The extent to which visual sensations bring on anxiety: numbers of subjects per rating scale point*

	Very much (3)	Somewhat (2)	Slightly (1)	Not at all (0)	Mean rating
Strip lights	22	17	15	29	1·4
Glare	15	21	24	23	1·3
Very bright sunshine	17	19	15	32	1·3
Sunlight broken by trees or railings	14	19	21	29	1·2
Bright light indoors	11	15	19	38	1·0
Sunlight reflected in water	11	13	17	42	0·8
Watching TV	2	5	26	50	0·8
Reading	1	5	24	53	0·5

Results

The responses to the visual sensations ratings are given in Table 1. (The order of the items has been rearranged so that they are presented in decreasing order of their tendency to elicit anxiety.) Though the mean levels were not high for any of the sensations (even for strip lights, the average rating is only part way between 'slightly' and 'somewhat'), it appeared that for some subjects some of these visual sensations could have a significant role in eliciting anxiety. For several of the sensations, a substantial minority (27% for strip lights) reported that 'very much' anxiety was caused.

To examine which agoraphobic subjects were most visually sensitive, the eight visual sensations ratings were summed. A matrix of correlations was then computed between this summed score and the other variables (see Table 2). The visual sensitivity score was found to correlate with the number of reported illusions seen in response to the provocative pattern. These two variables showed a very similar pattern of correlations with other variables, being highly associated with depersonalization, with somatic but not with behavioural or cognitive aspects of agoraphobia, and not with depression. However, surprisingly, correlations with headache variables were mostly not significant. Somatic aspects of agoraphobia correlated more highly with most other variables studied than behavioural or cognitive aspects. It was concluded that the initial study had given sufficient support to the role of provocative visual stimuli in agoraphobia to justify further investigation.

STUDY TWO

In the second study the visual sensations questionnaire (VSQ2) was revised and improved. The preliminary version had asked only about visual stimulation known to be of relevance to the induction of seizures and headaches. To assess whether these stimuli have any specific capacity to elicit anxiety reactions, the revised version included several non-visual stimuli and one visual stimulus not known to be of relevance to either epilepsy or migraine (a room lit by moonlight). Also, some of the stressful visual items were specified as occurring at home, so that the impact of visual stimuli could be separated from the effects of being away from home. The ratings made for each sensation were also expanded. The preliminary questionnaire had asked whether the stimuli brought on anxiety *or* made it worse. In the revised version, separate questions were asked about these. Questions were also asked about whether stimuli

Table 2. *Pearson correlation coefficients from the initial study*

	1	2	3	4	5	6	7	8	9
(1) Visual sensitivity	—	—	—	—	—	—	—	—	—
(2) Visual illusions	0·30**	—	—	—	—	—	—	—	—
(3) Depersonalization	0·47**	0·44**	—	—	—	—	—	—	—
(4) Agoraphobia – somatic	0·28**	0·30**	0·36**	—	—	—	—	—	—
(5) Agoraphobia – behavioural	0·14	0·14	0·11	0·32**	—	—	—	—	—
(6) Agoraphobia – cognitive	0·10	0·08	0·21	0·34**	0·19	—	—	—	—
(7) Headaches – number	0·40**	0·19	0·15	0·39**	0·18	0·28**	—	—	—
(8) Headaches – severity	0·04	0·19	0·23	0·28**	0·19	0·27**	0·32**	—	—
(9) Headaches – duration	0·18	0·10	0·25	0·19	0·15	0·08	0·28**	0·24*	—
(10) Depression	0·15	0·15	0·27	0·42**	0·28**	0·44**	0·23*	0·18	0·13

* $P < 0·05$; ** $P < 0·01$.

caused headaches and made headaches worse, in order to be able to examine to what extent the effects of visual sensations in people with agoraphobia were specific to anxiety reactions.

Experimental control was also introduced into the assessment of visual illusions by including a pattern with broad stripes. Fewer illusions are seen in response to broad stripes and they are not correlated with susceptibility to headaches (Wilkins *et al.* 1984). This allows individual differences in the role of response tendencies in the reporting of illusions to be controlled for.

In addition to refinement in the measured instruments, it was necessary to administer the visual sensations scale to a non-agoraphobic control group. It was hypothesized that the tendency for visual sensations to elicit anxiety would be specific to those with agoraphobia, and also that the latter would show more illusions than controls in response to the epileptogenic patterns. There might have been a case in these group comparisons for setting minimum criteria on the agoraphobic scales for inclusion in the agoraphobic group. However, any such cut-off points would have been arbitrary and it is the more experimentally cautious strategy not to exclude subjects with low scores.

Subjects

Three groups of subjects were used.

(*a*) A further sample of 49 people with agoraphobia recruited by advertisement in the Phobic Society newsletter, who completed the revised VSQ (VSQ2), the visual illusions tests and the depression, depersonalization and agoraphobia questionnaires used in the previous study. They had a range on the behavioural avoidance scale of Johnston *et al.* (1984) of 13–96 and a mean of 52.

(*b*) The agoraphobic subjects who took part in the previous study were contacted again, and asked to complete just the revised VSQ; 59 did so.

(*c*) A group of 30 control subjects recruited from the Applied Psychology Unit subject panel who completed the VSQ, the visual illusions test and the depersonalization questionnaire.

Method

The VSQ2 contained the 15 forms of stimulation given in Table 3. Each was rated on a 3-point scale (not at all; moderately; very much) for how much it 'brings on anxiety', 'makes anxiety worse', 'causes headaches' and 'makes headaches worse'. Visual illusions in response to the pattern with broad stripes (spatial frequency 0·5 cycles/cm) were assessed in exactly the same way as to the pattern with narrow stripes. The agoraphobia and depersonalization questionnaires were re-administered in the same form as before. The tests were sent out and returned by mail. To reduce carry-over effects between the two tests of visual illusions, subjects were asked

Table 3. *Differences between agoraphobics and controls in responses to the Visual Sensations Questionnaire (values of 't')*

	Bring on anxiety	Makes anxiety worse	Causes headaches	Makes headaches worse
Visually provocative situations				
Bright lights in public places	7·95**	8·98**	2·99**	1·41
Strip lights in public places	7·50**	8·53**	1·77	0·45**
Very bright sunshine	5·15**	6·43**	1·44	0·40
Glare	2·65**	3·40**	0·71	0·13
Sunlight broken by trees or railings	3·36**	4·77**	0·96	0·45
Sunlight reflected in water	3·90**	3·40**	1·46	1·07
Strip lights at home	2·33*	3·91**	2·75**	1·01
Bright lights (at home)	2·01*	2·75**	1·49	−0·29
Reading	5·06**	4·98**	−0·99	−1·26
Watching TV	−0·04	0·32	0·36	−0·66
Other situations				
Running your hand over a rough surface	−1·09	0·97	1·00	−0·41
Noise of a spin dryer	0·40	2·27	0·90	−0·32
A very sweet taste	3·34**	3·42**	0·97	−0·93
The smell of strongly scented flowers	1·42	2·93**	−0·15	−1·27
A room lit by moonlight	2·87**	3·67**	2·16	−0·18

* $P < 0·05$; ** $P < 0·01$.

to do one at the beginning (narrow stripes) and one at the end (broad stripes), with the other questionnaires between. (This order of presentation was used because it was deemed to be conservative; patients were more likely to report illusions to the broad stripes having first experienced the narrow stripes).

Results

The results for the VSQ2 will be reported first. To test the hypothesis that agoraphobic and control subjects differed specifically in their responses to stressful visual stimuli, two-way analyses of variance were run with groups and type of stimuli (visually provocative *v.* other) as the factors. The interaction term provides a test of the hypothesis that visually provocative stimuli produce more anxiety in agoraphobic than control subjects. The data from the two anxiety questions were combined into a single variable because they had given a similar pattern of results. The analysis of variance for anxiety responses showed main effects of groups ($F(1,136) = 16{\cdot}29$, $P < 0{\cdot}01$) and type of stimuli ($F(1,136) = 10{\cdot}04$, $P < 0{\cdot}01$) and the predicted interaction ($F\,1,136) = 10{\cdot}04$, $P < 0{\cdot}01$). The mean ratings per item differed for visually provocative situations (agoraphobics, $\bar{x} = 1{\cdot}53$; controls, $\bar{x} = 1{\cdot}4$) but not for other situations (agoraphobics, $\bar{x} = 1{\cdot}18$; controls, $\bar{x} = 1{\cdot}08$).

It might be pointed out that the ratings for the visually provocative situations were inflated by the inclusions among them of several outdoor situations. The first six items in the visually provocative group were therefore omitted and the analysis re-run with the remaining 4 photosensitive items and 5 other items. The main effects remained highly significant, and the interaction term, though somewhat reduced, was also still significant ($F(1,136) = 3{\cdot}86$, $P = 0{\cdot}05$).

A two-way analysis of variance was also run for the headache variable (again, the responses to the two questions were summed) with groups and type of stimuli (10 visually provocative *v.* 5 other) as the factors. There was a significant main effect of type situation ($F\,1,136) = 48{\cdot}3$, $P < 0{\cdot}01$) but no main effect of group ($F(1,136) = 0{\cdot}02$) and no interaction ($F(1,136) = 0{\cdot}88$). The effects of visually provocative situations are thus specific to anxiety in agoraphobics; comparable effects do not obtain for headaches.

To examine items individually, *t* tests were run, comparing groups, on each of the 15 items individually. The method of separate variance was employed because of the smaller number of subjects in the control group. The results are given in Table 3. They represent a strikingly consistent pattern of results. The groups differ significantly on all ten visual sensitivity items except that for both watching television 'brings on anxiety' and 'makes anxiety worse'. In contrast, the groups generally did not differ significantly in the extent to which visually provocative items caused headaches (though there are two exceptions to this) or make headaches worse. *The results for the two visual stress items that explicitly refer to being at home follow the same pattern as the other visual stress items.* The other items show few differences between groups, though there are some exceptions to this, e.g. a 'very sweet taste' and 'a room lit by moonlight'. Unfortunately, the latter was the only non-provocative visual situation included in the questionnaire. The analysis of the results for individual situations thus makes it impossible to reject the hypothesis that it is visual stimuli in general (cf. visually provocative stimuli in particular) which are prone to induce anxiety in agoraphobic subjects.

Before examining correlations between the VSQ and other variables, the groups were compared with respect to visual illusions and depersonalization. Visual illusions in response to the epileptogenic pattern were examined using a two-way analysis of variance with groups and patterns (narrow or broad stripes) as the factors. The main effect of patterns was significant ($F(1,48) = 80{\cdot}35$; $P < 0{\cdot}01$), with the 'narrow' pattern producing more illusions than the 'broad' in both the agoraphobic and control groups. There was no significant effect of groups, nor a significant interaction. As might be anticipated, the agoraphobic subjects reported higher levels of depersonalization than the controls (the means were 3·83 and 1·14 respectively; $t = 4{\cdot}24$, $P < 0{\cdot}01$).

Pearson correlation coefficients were computed between composite anxiety and headache scores from the VSQ (based on responses to the ten visually provocative situations), and measures of visual illusions, depersonalization, depression and agoraphobia. Of illusion measures, only correlations of the *difference* between illusions to narrow and broad stripes will be

Table 4. *Pearson correlation coefficients from the second study*

	1	2	3	4	5	6	7
(1) VSQ anxiety	—	—	—	—	—	—	—
(2) VSQ headaches	0·41**	—	—	—	—	—	—
(3) Visual illusions	0·25	0·32*	—	—	—	—	—
(4) Depersonalization	0·34*	0·47**	−0·01	—	—	—	—
(5) Agoraphobia-somatic	0·42**	0·36**	0·07	0·36**	—	—	—
(6) Agoraphobia-behavioural	0·15	0·30*	−0·02	0·29	0·41**	—	—
(7) Agoraphobia-cognitive	0·24*	−0·09	−0·03	0·11	0·66**	0·12	—
(8) Depression	0·24	0·26	0·07	0·49**	0·29	0·39**	0·49**

* $P < 0·05$; ** $P < 0·01$.

given. The correlations are listed in Table 4. The pattern of correlations is similar at many points to those reported from the initial study. Again, somatic aspects of agoraphobia correlate with behavioural and cognitive aspects of agoraphobia and with depersonalization, but the behavioural, cognitive and depersonalization measures do not correlate significantly with each other. Also, depersonalization and somatic aspects of agoraphobia are the variables that correlate significantly with anxiety ratings of the VSQ. They also correlate significantly with headache responses on the VSQ. The correlations of the visual illusions measure are somewhat disappointing. Only headache responses on the VSQ correlate with visual illusions; anxiety responses do not.

STUDY THREE

The third and final study was carried out to remedy two remaining problems in the comparison of agoraphobics and controls in responses to the Visual Sensitivity Questionnaire. First, the questionnaire was revised to include additional items in two categories crucial to the interpretation of the results which were poorly represented in VSQ2: (*a*) non-provocative visual stimuli and (*b*) provocative visual stimuli occurring indoors. Secondly, the subjects studied were (*a*) agoraphobic patients recruited from *clinical* sources, and (*b*) a control group consisting of other phobics selected, as far as possible, to be comparable in background anxiety to the agoraphobic patients. The latter was particularly important in checking the assumption that reported visual sensitivity was specific to agoraphobia, not to all phobic subjects. No attempt was made in this study to investigate further the within-group correlations between measures, as the clinical sample used for this study was necessarily smaller than those used previously.

Subjects

Two groups of subjects were studied.

(*a*) Twenty-one patients referred to psychiatrists or clinical psychologists for agoraphobic problems and whose agoraphobic status had been confirmed clinically.

(*b*) A control group of 21 other phobics (3 social phobics, 8 blood/injury phobics and 10 spider phobics). The social phobics were recruited from clinical sources; the other control phobics were volunteers taking part in other experiments selected as far as possible to have high state and trait anxiety scores (Spielberger *et al.* 1970).

Method

Subjects completed the new version of the Visual Sensitivity Questionnaire (VSQ3). The items are given in classified order in Table 5, though in the version completed by subjects the order was randomized. Since in VSQ2 the separate questions about 'brings on anxiety' and 'makes anxiety worse' had given comparable data, in VSQ3 questions were asked only about 'to what extent they cause anxiety'. The questions about headaches were combined in the same way.

To confirm differences in agoraphobic status between groups, subjects completed the agoraphobic cognitions questionnaire and body sensations questionnaire (Chambless *et al.* 1984) and mobility inventory (Chambless *et al.* 1985). They also completed the State-Trait Anxiety Inventory (Spielberger *et al.* 1970) as a check on how well they were matched on background anxiety.

Table 5. *Classified lists of stimuli included in the Visual Sensitivity Questionnaire in the third study*

Visually provocative: public buildings	
7*	Looking at the striped metal treads on an escalator
11**	Stroboscopic lighting (e.g. in a dance hall)
14**	Strip lighting in a supermarket
19**	A very brightly lit public building
Visually provocative: home	
3*	Working at home close to a naked light-bulb
9	Watching TV at home very close to the screen
13*	Strip lighting at home
18	A very brightly lit room at home
Visually provocative: outdoors	
1	Headlights of a car shining at you
5**	Glare from sunlight reflected in water
10	Very bright sunshine on a beach
16	Sunlight interrupted by passing trees
Non-provocative visual items	
2	Watching an egg-timer
6	A room lit by moonlight
8	Watching TV at home from a distance
17	Looking at a picture on the wall at home
Non-visual items	
4	Noise of a spin-dryer
12	A very bitter taste, as from vinegar
15	Noise of a low-flying aircraft
20*	Sharp pain, as from a needle

* Stimuli for which groups showed significantly different anxiety ratings on one-tailed t tests: * $P < 0.05$; ** $P < 0.01$.

Results

The groups showed highly significant differences on all measures of agoraphobic status: mobility (means = 26·1, 64·5 $t = 5.72$, $P < 0.001$), fear of body sensations (means = 8·86, 32·40, $t = 6.21$, $P < 0.001$), and cognitions (means = 12·00, 20·38, $t = 3.26$, $P < 0.001$). The agoraphobic group showed higher state anxiety (mean = 53·4, 44·5, $t = 2.22$, $P < 0.05$) and higher trait anxiety (means = 61·2, 50·1, $t = 4.33$, $P < 0.001$). However, there was a substantial band of trait anxiety scores (46–66) where the scores of the groups overlapped. Fourteen agoraphobic and fifteen control subjects fell within this band and they were selected for supplementary analyses. They still, of course, showed significant differences on the specific measures of agoraphobia, though their mean scores on state anxiety and trait anxiety were very close.

Analysis of the Visual Sensitivity Questionnaire began by dichotomizing items into (*a*) visually provocative (regardless of where they occurred) and (*b*) not visually provocative (both non-provocative visual items and non-visual items). An analysis of variance (groups × items) was run for anxiety ratings, which produced a highly significant interaction ($F(1,40) = 11.87$, $P < 0.001$) indicating that the agoraphobic patients showed a higher mean response to provocative visual situations (24·9, cf. 18·6) but not to other situations (12·6 cf. 12·0). This interaction remained at least borderline significant ($F(1,27) = 4.10$, $P = 0.053$ when the analysis was re-run on the subset of subjects with matched trait and state anxiety scores. A comparable analysis was run on headache ratings for the same situations, but the interactions did not approach significance ($F(1,27) = 1.07$).

Differences between agoraphobic and control groups were then run on anxiety responses for the five separate groups of items (see Table 1) using t tests. (One-way tests were used as by this stage there was a directional prediction.) Groups differed highly significantly on visually provocative stimuli, not only in public buildings ($t = 4.52$, df = 40, $P < 0.001$) but also when they occurred at home ($t = 1.69$, df = 40, $P < 0.05$). The difference between groups when they occurred outdoors fell short of significance ($t = 1.50$, df = 40). Group differences for non-visual stimuli ($t = 0.39$) and non-provocative visual stimuli ($t = 0.74$) did not approach significance.

With the relatively small samples available for this third study, group comparisons of individual items carry a risk of type II errors. However, individual items that differed significantly in their anxiety ratings on one-tailed t tests are asterisked in Table 5.

It is thus in public buildings that provocative visual stimuli are most likely to cause anxiety in agoraphobics. However, the effect is by no means confined to public buildings. It is particularly important that, even at home, a generally 'safe' place in agoraphobia, provocative visual stimuli cause more anxiety in the agoraphobic patients. These results are also clearer than the previous ones in showing that none of the non-provocative visual stimuli included in the questionnaire cause more anxiety in the agoraphobic patients.

GENERAL DISCUSSION

The main findings can be summarized as follows.

1. Certain visual stimuli are reported by agoraphobic subjects as eliciting anxiety. The

agoraphobic subjects differ from the controls in the extent to which these stimuli bring on anxiety, but not in the extent to which they provoke headaches. The stimuli concerned are mainly those that cause migraine or elicit seizures in patients with photosensitive epilepsy. They are most likely to do so in public buildings. However, they can also do so at home or outdoors, though the effects here are weaker and less reliable. Non-visual stimuli and non-provocative visual stimuli are generally not reported by agoraphobics as bringing on anxiety. (Occasional exceptions have been found, though the two such items found to differentiate groups in study two were not replicated in study three.) This relative specificity permits the rejection of the 'response bias' hypothesis that in agoraphobia there is a tendency to report higher levels of anxiety than controls for all stimuli indiscriminately. Also, the fact that the items relating to lights at home show differences between the anxiety reactions of agoraphobic and control subjects permits the rejection of the hypothesis that visual stimuli are only reported as eliciting anxiety because they generally occur in places where agoraphobics are anxious for other reasons. Finally, the tendency of agoraphobic subjects to report higher anxiety reactions to visual provocation is not explicable in terms of their background general anxiety as the difference holds up even when they are compared with other phobics matched on state and trait anxiety.

2. In both studies, somatic aspects of agoraphobia correlate significantly with other phobic response systems, but these other measures (avoidance behaviour, cognitive aspects, depersonalization) do not correlate significantly with each other. In both studies, reports by agoraphobic subjects of anxiety reactions to visually provocative stimuli are correlated with somatic aspects of agoraphobia and depersonalization, but not with depression or with behavioural or cognitive aspects of agoraphobia. These facts are consistent with the view that the physiological aspects of agoraphobia are fundamental. Further, the specificity in the pattern of correlations also assists in rejecting an explanation of the data solely in terms of a response bias to report dysfunction. The role of depersonalization here is reminiscent of Roth's concept of the 'phobic anxiety – depersonalization syndrome', and suggests that visual sensitivity may be a feature of those agoraphobics who experience depersonalization.

3. Though the first study found that anxiety reactions to stressful visual stimuli were predictable from visual illusions to the epileptogenic pattern, this was not replicated in the subsequent studies. Neither did agoraphobic subjects show more visual illusions in response to this pattern than controls. So caution needs to be exercised in assuming that the psychological mechanisms involved in the epileptogenic pattern are also involved in the anxiety responses to provocative visual situations in agoraphobia.

Additional empirical data on visual sensitivity in response to fluorescent light in agoraphobia has been made available by Hazell (personal communication). The possibility arises that the rapid fluctuation in light intensity of fluorescent light contributes to anxiety in agoraphobia, following the finding of Wilkins *et al.* (1989) that it is responsible for more than half the headaches and eye-strain suffered by office workers. Hazell *et al.* have compared the responses of agoraphobic volunteers, tested in their own homes, to conventional pulsating fluorescent light and outwardly identical fluorescent lighting in which electronic circuitry was used to reduce the pulsation. Although subjects could not distinguish the two forms of fluorescent lighting, their pulse was higher under the conventional fluorescent lighting. Another relevant finding is that agoraphobics show higher anxiety scores on the Multiple Adjective Checklist under fluorescent than incandescent lighting, a difference not found either in control or agoraphobic subjects tested post-treatment (Hobbs *et al.* 1984).

It is reasonable to conclude that stressful visual stimuli can contribute to the anxiety reactions of agoraphobic patients. This does not justify extravagant claims; there is no basis for suggesting that agoraphobia can be explained wholly in these terms. However, a role in aetiology cannot be excluded. It is possible that certain people develop agoraphobia after exposure to intense fluorescent lighting, which is found predominantly in public places. The mechanisms by which visual sensations might contribute to the anxiety reactions of agoraphobic patients will now be considered, though our data do not distinguish between them clearly.

One account would be closely modelled on the interpretation Wilkins has already offered of visual sensations in epilepsy, headaches, eyestrain and discomfort (Wilkins *et al.* 1984; Wilkins, 1986). Though a wide variety of dysfunctional reactions can be produced by the same visual stimuli (many of them predictable from illusional responses to the epileptogenic pattern) the mechanisms may not be identical in each case. Advances in the neuropsychology of anxiety (Gray, 1982) are developing to the point where we may soon begin to speculate about the neurological basis of panic attacks in agoraphobia, and the source of vulnerability to them. Also, positron emission tomography shows that in patients with panic disorder there is asymmetry of cerebral blood flow in a region of the parahippocampal gyrus, even when panic attacks are in remission (Reiman *et al.* 1984). This phenomenon showed a very close association with an abnormal anxiety response to lactate infusion in panic disorder patients (Leibowitz *et al.* 1984). Such work points to panic attacks having a basis in a discrete abnormality in a region of the brain known to be associated with emotion, and closely related anatomically to that involved in epileptic seizures. However, it is not known how excitement of the visual system in agoraphobic patients could trigger the massive response in this area of the brain that seems to underlie panic.

An alternative account could be given based on higher level processes of visual perception. There is evidence (Watts, 1989) that agoraphobic patients try to cope with anxiety by reducing their processing of the external environment, although this is often a counter-productive strategy and can increase anxiety. In similar vein, Weckowitz (1970) has theorized that a suspension of active perceptual processing is the basis of depersonalization. It could be that provocative visual stimuli contribute to the disruption of active processing in vulnerable patients, thus contributing to anxiety and depersonalization.

Yet a third possibility is that the degree of anxiety that visual stress causes will depend on how its direct effects are *interpreted*. In normal observers, the observation of patterns such as Fig. 1 can induce unpleasant somatic sensations. In subjects predisposed to catastrophic interpretations of somatic disturbances, these stressful visual stimuli may have a particularly powerful effect. In this way, the role of visual sensations in eliciting anxiety in agoraphobics could be accommodated with current cognitive models of panic (Clark, 1986) which give a primary place to the tendency to regard bodily sensations as unpleasant and to interpret them catastrophically. There is no incompatability between a basic physiological vulnerability and a tendency to worry excessively about physical sensations (Watts, 1988).

We are grateful to Andrew MacLeod, Zafra Cooper and Kieran Coyle for assistance with the research reported here.

REFERENCES

Benedikt, V. (1870). Über Platschwindel. *Algemeine Wiener Medizinische Zeitung* **15**, 488.

Carroll, B. J., Feinberg, M., Smouse, P. E., Rawson, S. G. & Greden, J. F. (1981). The Carroll rating scale for depression. I. Development, reliability and validation. *British Journal of Psychiatry* **138**, 194–200.

Chambless, D. L., Caputo, G. C., Bright, P. & Gallagher, R. (1984). Assessment of fear in agoraphobics: the body sensations questionnaire and the agoraphobic cognitions questionnaire. *Journal of Consulting and Clinical Psychology* **52**, 1090–1097.

Chambless, D. L., Caputo, G. C., Jasin, S., Gracely, E. & Williams, C. (1985). The mobility inventory for agoraphobia. *Behaviour Research and Therapy* **23**, 35–44.

Clark, D. M. (1986). A cognitive approach to panic. *Behaviour Research and Therapy* **24**, 461–470.

Dixon, J. C. (1963). Depersonalization phenomena in a sample of college students. *British Journal of Psychiatry* **109**, 371–375.

Foa, E. B., Steketee, G. & Young, M. C. (1984). Agoraphobia: phenomenological aspects, associated aspects and theoretical considerations. *Clinical Psychological Review* **4**, 431–457.

Gray, J. A. (1982). *The Neuropsychology of Anxiety: An Enquiry into the Function of the Septo-Hippocampal System.* Oxford University Press: Oxford.

Hallam, R. S. (1978). Agoraphobia: A critical review of the concept. *British Journal of Psychiatry* **133**, 314–319.

Hallam, R. S. (1985). *Anxiety: Psychological Perspectives on Panic and Agoraphobia.* Academic Press: London.

Hamilton, M. (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery and Psychiatry* **23**, 56–62.

Harper, M. & Roth, M. (1962). Temporal lobe epilepsy and the phobic anxiety – depersonalization syndrome. *Comprehensive Psychiatry* **3**, 129–151.

Hobbs, W. R., Wilkinson, C., Peterson, G., Laraia, M., Cox, D. & Ballinger, J. (1984). *The Psychophysiology of Agoraphobia.* American Psychiatric Association Press: Washington.

Johnston, M., Johnston, D. W., Wiles, H., Burns, L. E. & Thorpe, G. L. (1984). Cumulative scales for the measurement of agoraphobia. *British Journal of Clinical Psychology* **23**, 133–143.

Liebowitz, M. R., Fryer, A. J., Gorman, J. M., Dillon, D., Appleby, I. L., Levy, G., Anderson, S., Levitt, M., Palij, M., Davies, S. O. & Klein, D. F. (1984). Lactate provocation of panic attacks. I. Clinical and behavioural findings. *Archives of General Psychiatry* **41**, 746–770.

Mayer-Gross, W. (1935). On depersonalization. *British Journal of Medical Psychology* **15**, 103–115.

Nulty, D. D., Wilkins, A. J. & Williams, J. M. G. (1987). Mood, pattern sensitivity and headache: a longitudinal study. *Psychological Medicine* **17**, 705–713.

Reiman, E. M., Raichle, M. E., Butler, F. K., Herscovitz, P. & Robins, E. (1984). A focal brain abnormality in panic disorder, a severe form of anxiety. *Nature* **310**, 683–685.

Roth, M. & Harper, M. (1962). Temporal lobe epilepsy and the phobic anxiety – depersonalization syndrome. Practical and theoretical considerations. *Comprehensive Psychiatry* **3**, 215–226.

Sedman, G. (1970). Theories of depersonalization: a re-appraisal. *British Journal of Psychiatry* **117**, 1–14.

Shorvon, H. J., Hill, J. D. N., Burkitt, E. & Halstead, H. (1946). The depersonalization syndrome. *Proceedings of the Royal Society of Medicine* **39**, 779–792.

Spielberger, C. D., Gorsuch, R. L. & Luschene, R. E. (1970). *Manual for the State–Trait Anxiety Inventory (Self-evaluation Questionnaire)*. Consulting Psychologists Press: Palo Alto, California.

Watts, F. N. (1988). Agoraphobia: the changing face of treatment. In *New Developments in Clinical Psychology, Vol. 2* (ed. F. N. Watts), pp. 53–66. John Wiley: Chichester.

Watts, F. N. (1989). Attentional strategies and agoraphobic anxiety. *Behavioural Psychotherapy* **17**, 15–26.

Weckowitz, T. (1970). Depersonalization. In *Symptoms of Psychopathology: A Handbook* (ed. C. G. Costello), pp. 151–166. John Wiley: New York.

Wilkins, A. J. (1986). What is visual discomfort? *Trends in Neurosciences* **9**, 343–346.

Wilkins, A. J., Nimmo-Smith, I., Tait, A., McManus, I. C., Della Sala, S., Tilley, A., Arnold, K., Barrie, M. A. & Scott, S. G. C. (1984). A neurological basis for visual discomfort. *Brain* **107**, 989–1017.

Wilkins, A. J., Nimmo-Smith, I., Slater, A. I., & Bedocs, L. (1989). Fluorescent lighting, headaches and eye-strain. *Lighting Research and Technology* **21**, 11–18.