Photophobia and autonomic responses to facial pain in migraine

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Summary

Subjective and autonomic responses to visual stimulation and facial pain were investigated in 20 migraine sufferers and 21 ‘non-headache’ control subjects. Ratings of glare- and light-induced pain were greater in migraine sufferers than control subjects. In migraine sufferers, glare ratings increased during painful mechanical stimulation of the nasal ala, the side of the nose and the back of the neck. Glare ratings decreased in both groups during painful stimulation of the chin. Light-induced pain increased during painful stimulation of all four sites in migraine sufferers, but not control subjects. Increases in forehead pulse amplitude during painful mechanical stimulation were greater bilaterally in migraine sufferers than in control subjects, consistent with loss of inhibitory influences on vascular reactions in the face. Visual stimulation facilitated lacrimation when the nasal ala was pinched, but visual stimulation coupled with pain elsewhere in the head and neck did not. The lacrimal response to combined nasal ala and visual stimulation was absent on the symptomatic side in patients with unilateral headache, indicating local parasympathetic deficit in migraine. These findings suggest that migraine is associated with loss of inhibitory subcortical processes which normally suppress sensations of glare and light-induced pain, and which may also suppress vasodilator responses to facial pain. Loss of inhibitory pain-control mechanisms could interact in a vicious circle with autonomic disturbances during migraine.

Keywords: migraine; photophobia; vasodilatation; lacrimation; pain

Introduction

Most migraine sufferers become sensitive to light during migraine headache (Selby and Lance, 1960; Drummond, 1986). Photophobia can take two forms—a sense of glare or ‘dazzle’, or an increase in pain in the presence of bright light. Although most prominent during attacks of migraine, photophobia can also persist during the headache-free interval (Drummond, 1986) and may influence the onset of attacks. For example, patients have noted the development of migraine shortly after intense visual stimulation such as bright sunlight or the flash of headlights while driving at night (Debney, 1984).

The studies of Wolff (1963) established that painful stimulation within the distribution of the ophthalmic division of the trigeminal nerve induced blinking (a sign of photophobia) in the presence of bright light. Wolff also noted that other features of photophobia, such as visual pain and lacrimation, developed during these procedures, although these responses were not measured formally. Drummond and Woodhouse (1993) investigated whether painful stimulation within the distribution of the ophthalmic nerve increased the subjective sensation of photophobia to the same extent in migraine sufferers and headache-free control subjects. To induce pain, ice was applied to the mid-forehead while the discomfort threshold to an increasingly intense light was assessed. Tolerance to bright light decreased during cold-induced pain in migraine sufferers but not in control subjects, suggesting that the mechanism responsible for photophobia was more responsive to trigeminal input in migraine sufferers than control subjects.

The aim of the present study was to investigate further the interaction between trigeminal and visual inputs in the production of photophobia in migraine sufferers. Drummond (1986) reported that photophobia was usually greater on the affected than the unaffected side in patients with unilateral migraine. Thus, it was hypothesized that painful stimulation within the ophthalmic nerve distribution would intensify photophobia ipsilaterally in migraine sufferers. To account for the referral of pain from the back of the neck to behind the forehead and eye, Kerr (1961) suggested that afferent cervical volleys converge upon the descending tract and...
nucleus of the trigeminal nerve in the brainstem and dorsal cord. Neurophysiological evidence of this convergence was subsequently obtained in cats (Kerr and Olafson, 1961). The convergence of cervical and trigeminal inputs raises the possibility that painful occipital stimulation might increase photophobia by activating central trigeminal nuclei. To investigate this possibility, photophobia during painful occipital and ophthalmic stimulation was compared with photophobia during painful stimulation of the chin (outside the distribution of the ophthalmic and upper cervical nerves and therefore chosen as a control procedure).

Photostimulated pain in the eye and nostrils evokes ipsilateral lacrimation and cutaneous vasodilatation in the forehead; these responses are mediated by trigeminal–parasympathetic reflexes (Drummond, 1992, 1995a). During headache, activation of trigeminal–parasympathetic reflexes might contribute to pain by potentiating vasodilatation in pain-sensitized extracranial and intracranial vessels (Drummond and Lance, 1983). The symptomatic eye often waters profusely during attacks of cluster headache, consistent with activation of trigeminal–parasympathetic reflexes, but lacrimation develops only rarely during migraine. Investigation of cardiovascular and pupillary reflexes suggests a mild parasympathetic deficit in migraine, which might be associated with supersensitivity to nitric oxide released from perivascular nerve endings (Thomsen and Olesen, 1995). In the present study, vascular and lacrimal responses to painful mechanical and visual stimulation were investigated in migraine sufferers and control subjects, to determine whether parasympathetic reflexes in the face are impaired in migraine.

**Method**

**Subjects**

Migraine sufferers and control subjects were recruited by advertisement from the university and wider community. Each subject provided informed consent for the procedures, which were approved by the Murdoch University ethics committee.

The sample of migraine sufferers consisted of 17 females and three males who met the International Headache Society (1988) criteria for migraine with aura (seven subjects) or migraine without aura (13 subjects). Their ages ranged between 15 and 57 years (mean 36 ± 13 years). All but three of the 20 migraine sufferers reported that they were sensitive to light during most or all of their headaches; the other three subjects reported that they were occasionally sensitive to light during their headaches. Most of them took analgesic medication during attacks of migraine, supplemented in some cases by ergotamine, sumatriptan, codeine, anti-inflammatory or anti-emetic drugs. One took pizotifen and another took propranolol to prevent migraine headaches; however, since they both continued to have frequent attacks of migraine, they were included in the study. Headache frequency ranged between one every 2 months to two per week (mean frequency 23 headaches per year). All subjects were studied during a headache-free interval. Eleven subjects reported that all, or nearly all, of their headaches recurred on the same side. In three subjects the headaches were unilateral but recurred on either side with similar frequency; in the other six subjects, headache affected both sides of the head. In subjects whose headaches recurred on the same side, ratings and physiological responses were investigated in relation to the usual side of headache.

The control group consisted of 18 females and three males without a history of migraine headaches, who reported fewer than eight headaches per year, all mild. Ages in the control group ranged between 17 and 56 years (mean 33 ± 10 years).

**Procedures**

The experiment was carried out in an air-conditioned laboratory maintained at 22 ± 1°C. Pulse transducers (photoplethysmographs, Grass Instruments Company) were attached with double-sided adhesive tape to each side of the forehead, 1 cm above the eyebrows and 3 cm from the midline. To prevent room lighting from interfering with photoelectric signals, the pulse transducers were covered with a black cloth band which was secured lightly at the back of the subject’s head with Velcro tape. Pulse waveforms were displayed on a chart recorder and stored on computer for later analysis using Biopac software. To measure corneal moisture (reflecting lacrimation), dry nitrogen (300 ml/min) was blown through each chamber of a pair of swimming goggles placed over the subject’s eyes. Since blinking influences corneal moisture by spreading lacrimal secretions across the cornea, subjects were required to blink in synchrony with a tone that sounded every 5 s. The humidity of the nitrogen stream after it had passed over the cornea was measured with Vaisala HMI32 temperature and humidity sensors. Unlike Shirmer’s test, this method does not initiate reflex secretion of tears and provides a continuous measure of corneal moisture that is responsive to facial pain (Drummond, 1995a).

In the first part of the experiment, a pressure algometer was applied at the subject’s pain tolerance level to the upper neck within the distribution of the greater occipital nerve, to the anterior aspect of the chin, and over bone on the side of the nose. In addition, spring-loaded forceps were applied to the nasal ala at the subject’s pain tolerance level. Sites on each side of the face and neck were tested. Pressure applied to the rounded metal tip (5-mm diameter) of the algometer produced a digital readout proportional to the applied pressure. The pressure of application of the forceps was measured by the extent of compression of a spring attached to one of the forcep handles. Subjects were told beforehand that the aim of the experiment was to investigate physiological responses to facial pain, and that it was important to tolerate as much pain as they could during each procedure. The algometer or forceps pressure increased rapidly until the subject signalled to stop or until a predetermined limit was
reached (the pain tolerance level); the pressure was then held at this level for a further 30 s. Sites were tested in random order, with a recovery period of at least 3 min between each test.

Next, an ophthalmoscope light was shone directly into each of the subject’s eyes for 30 s, from a distance of 10 cm. Each eye was tested separately, with ~60 s between tests. Because the light was extremely bright, subjects rated glare on a scale of 1–10 where 1 corresponded to ‘glarey’ and 10 to ‘the most dazzling light they had ever seen’. In addition, they rated light-induced pain on a 1–10 scale where 1 corresponded to ‘not at all painful’ and 10 to ‘extremely painful’.

In the final part of the experiment, the ophthalmoscope light was shone into one of the subject’s eyes during painful stimulation of each site on the face and neck. The algometer or forceps pressure increased quickly to the level established as the subject’s pain tolerance level for that site and was held at that level for 30 s. At the same time, the ophthalmoscope light was shone into the eye on the usual side of headache, or either the left or right eye (selected at random) in control subjects and patients with alternating or bilateral headaches. The light was shone into the same eye while each site on the face and neck was tested. Thus, the light was ipsilateral to the site of painful stimulation during half of the tests, and contralateral to the site of stimulation during the other tests. Sites were tested in random order, with a recovery period of at least 3 min between each test. Subjects rated glare and light-induced pain, as described above. Finally, ratings of glare and light-induced pain to 30 s of visual stimulation were obtained separately for each eye, in the absence of painful mechanical stimulation.

**Statistical analyses**

Responses were investigated with analyses of variance for repeated measures (SPSS for Windows, Version 6.1). The multivariate solution was used for repeated measures factors with more than two levels. Details of individual analyses are described in the Results.

**Results**

**Pain tolerance, glare ratings and light-induced pain**

Pressures applied at the pain tolerance level did not differ between migraine and control subjects at any of the sites in the face or neck, and did not differ between the symptomatic and nonsymptomatic sides in patients whose headaches usually recurred on the same side. In addition, pressures applied at the pain tolerance level did not differ between patients who had had an attack of migraine within the past 7 days and those whose most recent headache had finished >7 days before.

Ratings of glare and light-induced pain were investigated in separate analyses of variance with one between-groups factor (migraine versus control) and one repeated measures factor (before, during and after painful mechanical stimulation). Both sets of ratings were greater in migraine sufferers than in control subjects [for glare, \(F(1,39) = 19.30, P < 0.001\); for light-induced pain, \(F(1,39) = 7.12, P < 0.05\)] (see Fig. 1), but did not differ between the two sides in patients whose headaches usually recurred on the same side. Ratings of glare and light-induced pain increased over the course of the experiment in migraine sufferers; in control subjects, however, glare ratings decreased during and after painful mechanical stimulation, and light-induced pain was minimal throughout the experiment [interaction between groups and time: for glare ratings, \(F(2,78) = 5.08, P < 0.01\); for light-induced pain, \(F(2,78) = 3.29, P < 0.05\)] (see Fig. 1).

To determine whether painful mechanical stimulation at various sites in the face and neck influenced photophobia ratings, the difference between ratings during painful stimulation and ratings during visual stimulation alone was calculated. These change scores were investigated in analyses of variance containing one between-groups factor (migraine versus control subjects) and two repeated measures factors: site of mechanical stimulation (side of the nose, nasal ala, back of the neck and chin) and side of mechanical stimulation (ipsilateral or contralateral to visual stimulation). In general, ratings increased during painful stimulation in migraine sufferers but not in control subjects [difference between groups: for glare, \(F(1,38) = 4.67, P < 0.05\); for light-induced pain, \(F(1,38) = 5.66, P < 0.05\)] (see Figs 2 and 3). Neither the side nor site of mechanical stimulation influenced ratings of light-induced pain (Fig. 3). However, glare ratings tended to increase during mechanical stimulation of the nose and neck, but they decreased during mechanical stimulation of the chin [\(F(3,36) = 4.42, P < 0.01\), Fig. 2]. Ratings did not differ between sides in patients whose headaches usually recurred on the same side.

Some subjects reported spontaneously that the intensity of pain had changed when mechanical stimulation was repeated during visual stimulation, and others were unable to tolerate stimulation at the previous level. On average, tolerance of mechanically-induced pain increased in control subjects but decreased in migraine sufferers during visual stimulation (Mann–Whitney \(U\) test, \(Z = 3.26, P < 0.01\)).

**Vascular and lacrimal responses to facial pain**

The vascular pulse amplitude was measured on both sides of the forehead for 15 s before each mechanical stimulus, and during the final 15 s of stimulation. Because the pulse transducers measured only relative changes in pulse amplitude, the vascular response to stimulation was expressed as a percentage change from baseline. Baseline humidity levels (reflecting corneal moisture) were measured for 30 s before each mechanical stimulus; because the lacrimal response to mechanical stimulation developed slowly, the response was defined as the maximum difference between...
Fig. 1 Ratings for glare- and light-induced pain, averaged (±SEM) over sides and sites of mechanical stimulation. In Figs 1–6, error bars represent the SEM.

Fig. 2 Changes in glare ratings during painful mechanical stimulation (averages ± SEM). Each bar represents the difference between ratings taken before and during painful mechanical stimulation. Mechanical stimulation was ipsilateral (Ips.) to visual stimulation in 50% of trials, and contralateral (Ctra.) to visual stimulation in the other 50% of trials.

Fig. 3 Changes in light-induced pain during painful mechanical stimulation (averages ± SEM). Experimental conditions and abbreviations are the same as those in Fig. 2.

This baseline level and the mean humidity level during four consecutive 30-s intervals following the onset of stimulation.

To simplify the interpretation of findings, separate analyses were computed for each site of mechanical stimulation. Each analysis of variance had one between-groups factor (migraine versus control subjects) and two repeated measures factors: visual stimulation (no visual stimulation versus visual stimulation ipsilateral to the side of mechanical stimulation versus visual stimulation contralateral to the side of mechanical stimulation) and the laterality of vascular or lacrimal responses (ipsilateral or contralateral to mechanical stimulation).

As shown in Fig. 4, vascular responses to mechanical stimulation were greater in migraine sufferers than in control subjects (for the nasal ala, F(1,37) = 6.78, P < 0.05; for the neck, F(1,38) = 7.97, P < 0.01; for the chin, F(1,37) = 5.81, P < 0.05; for the nose, F(1,37) = 5.25, P < 0.05). Before visual stimulation, vascular responses to stimulation of the nasal ala were greater ipsilaterally than contralaterally [F(1,38) = 9.42, P < 0.01]. However, responses decreased in control subjects during the latter stages of the experiment so that, when averaged over the entire experiment, responses did not differ significantly between the two sides [F(1,37) = 3.12, P = 0.086]. Vascular responses to stimulation of the nose with the algometer decreased over the course of the experiment, so that responses were smaller in the presence than the absence of visual stimulation [F(2,36) = 4.53, P < 0.05]. Whether mechanical stimulation was ipsilateral or contralateral to visual stimulation did not influence vascular responses. In patients whose headaches usually recurred on the same side, vascular responses were similar on the symptomatic and nonsymptomatic sides throughout the experiment.

Lacrimal responses during mechanical stimulation are shown in Fig. 5. Pinching the nasal ala with forceps induced maximal responses ipsilaterally [laterality of response, F(1,36) = 9.03, P < 0.01]. In addition, the combination of visual and mechanical stimulation induced more ipsilateral lacrimation than mechanical stimulation alone [interaction between visual stimulation and laterality of response to nasal ala stimulation, F(2,35) = 3.45, P < 0.05]. Increases in lacrimation were, on average, greater in migraine sufferers than in control subjects when the nasal ala contralateral to the visual stimulus was pinched (Fig. 5). However, this difference in response between migraine sufferers and control subjects was not statistically significant. Mechanical
Photophobia in migraine

Fig. 4 Changes in forehead blood flow during painful mechanical stimulation (averages ± SEM). Vascular responses were monitored ipsilaterally (Ips.) and contralaterally (Ctra.) to the mechanical stimulus. The mechanical stimulus was applied to the left and right sides at each site. Responses monitored before visual stimulation (‘Light Off’ condition) were averaged across the left and right sides. During visual stimulation, the mechanical stimulus was ipsilateral to the light in 50% of trials (‘Ips. Light’ condition) and contralateral to the light in the other 50% of trials (‘Ctra. Light’ condition).

Fig. 5 Lacrimal response to painful mechanical stimulation (averages ± SEM). Values represent the change in corneal moisture, measured as the change in humidity in a stream of dry nitrogen passing over the cornea. Experimental conditions and abbreviations are the same as those in Fig. 4.
stimulation of other parts of the face induced minor bilateral responses; for the chin, the combination of visual and mechanical stimulation induced greater responses than mechanical stimulation alone \( F(2,36) = 7.89, P < 0.001 \).

Figure 5 shows that lacrimation increased in migraine sufferers when visual stimulation was accompanied by painful stimulation of the contralateral nasal ala. However, lacrimation was minimal when the nasal ala was pinched ipsilaterally. The visual stimulus was applied on the symptomatic side in patients with unilateral headache; therefore, the findings suggest that lacrimation was minimal on the symptomatic side in patients with unilateral headache. Investigation of lacrimal responses in patients whose headaches usually recurred on the same side. When the nasal ala was pinched on the nonsymptomatic side, the ipsilateral lacrimal response was greater than the contralateral response \( *P < 0.05 \). However, this response was absent when the symptomatic side was stimulated.

Discussion

Pain tolerance in migraine

The link between psychological factors and headache has fostered the impression that migraine sufferers have a low complaint threshold and little tolerance for pain. However, this impression has not been confirmed experimentally (Drummond, 1987). In the present study, tolerance to painful mechanical stimulation of the head and neck was similar in migraine sufferers and control subjects when tested at the start of the experiment. Tenderness usually develops in scalp and neck tissues during attacks of migraine (Wolff et al., 1953), and often persists for several days after the headache has resolved (Drummond, 1987). In the present study, even patients who had suffered an attack of migraine within the past 7 days tolerated normal levels of mechanical stimulation initially; thus, any residual scalp tenderness apparently did not influence their tolerance levels.

Photophobia

As in previous studies (Drummond, 1986; Drummond and Woodhouse, 1993), migraine sufferers reported more visual discomfort than control subjects. In addition, glare ratings and light-induced pain increased during painful mechanical stimulation of the face and neck in migraine sufferers, but not in control subjects. Heightened sensitivity to glare might be a symptom of 'subclinical migraine' persisting between episodes of headache, or could form part of a migraine predisposition. Release of inhibitory processes in the thalamus or cerebral cortex seems to cause an exaggerated sense of glare (Cummings and Gittinger, 1981). In general, glare ratings increased during painful mechanical stimulation in migraine sufferers and persisted at high levels afterwards. In contrast, glare ratings decreased over the course of the experiment in control subjects. Photophobia also increased during repeated visual stimulation in migraine sufferers during attacks (Drummond, 1986), consistent with cumulative fatigue of an inhibitory process which normally suppresses the experience of glare. Chronicle and Mulliners (1996) postulated that dysfunction of inhibitory interneurons in the primary visual cortex mediates persistent visual disturbances in migraine; a similar disturbance at the subcortical level might heighten the sense of glare (Coombs et al., 1994).

Glare ratings increased in migraine sufferers during painful stimulation of the neck and nose, but not during stimulation of the chin. Afferent activity from the neck converges with frontal activity in the trigeminal nucleus caudalis (Kerr, 1961). The present findings suggest that signals from the trigeminal nucleus interact with visual traffic in the thalamus or cerebral cortex. Alternatively, counter-irritation during painful stimulation of the chin might inhibit glare. Since glare ratings are subjective, a response bias in migraine sufferers cannot be ruled out. However, the systematic variation in ratings across stimulation sites weakens this possibility.

Drummond and Woodhouse (1993) reported that painful stimulation of the forehead increased visual discomfort in migraine sufferers but not in control subjects. Similarly, in the present study, ratings of light-induced pain increased during painful mechanical stimulation of the face and neck in migraine sufferers but not in control subjects. Wolff’s studies indicated that irritation within the region supplied by the ophthalmic division of the trigeminal nerve facilitated blinking to intense light (Wolff, 1963). Thus, it was expected that pain from the nose would increase sensitivity to light; it was also hypothesized that pain referred from the neck, but not the chin, would increase light-induced pain. In fact, light-induced pain increased during stimulation of all sites in
migraine sufferers. Further studies are required to determine whether the facilitatory effect of painful mechanical stimulation on light-induced pain is nonspecific, or is limited to the head and neck.

Drummond (1986) reported that light-induced pain increased during attacks of migraine, and was greater on the symptomatic side in patients with unilateral headache. Thus, it was expected that photophobia would increase ipsilaterally during painful stimulation of the face. However, this was not confirmed. Despite being extremely glarey, the visual stimulus induced only minor levels of pain. Specifically, light-induced pain averaged only 1 or 2 units on a 10-point scale in migraine sufferers during mechanical and visual stimulation, and was virtually absent in control subjects. In contrast, pain ratings to moderately bright light averaged ~20 on a 0–40 scale during headache (Drummond, 1986), possibly because both eyes were stimulated simultaneously (Wirschafter and Bourassa, 1966) or because visual stimuli were presented after a short period of dark-adaptation. Alternatively, the facilitatory effect of headache on light-induced pain may be greater than that of brief facial pain. Photophobia frequently develops in the normal eye when the other eye is inflamed or injured (Walsh and Hoyt, 1969); presumably the afferent signals responsible for photophobia spread bilaterally in the brainstem or higher centres. Nevertheless, photophobia is greater on the symptomatic side in patients with unilateral migraine (Drummond, 1986). Systematic manipulation of the site of trigeminal stimulation (unilateral or midline) and visual stimulation (one or both visual fields in one or both eyes) might identify the conditions required for asymmetry of photophobia.

**Autonomic responses to facial pain and visual stimulation**

Drummond (1995a) reported that lacrimation and forehead pulse amplitude increased bilaterally when the nasal ala was pinched with forceps; however, the ipsilateral response was greater than the contralateral response. The close relationship between lacrimal and vascular responses, and the inhibitory influence of a facial nerve lesion on vascular responses, indicates that parasympathetic vasodilator fibres in the facial nerve normally participate in the response (Drummond, 1995a). In the present study, forehead pulse amplitude increased ipsilaterally when the nasal ala was pinched, but painful stimulation elsewhere in the face and neck did not evoke the ipsilateral component of response. Visual stimulation potentiated lacrimation but did not facilitate ipsilateral vasodilatation when the nasal ala was pinched, possibly because of tachyphylaxis of the vascular response (Toda et al., 1997) or perhaps because an increasing constrictor influence overshadowed the dilator response in control subjects. Importantly, the bilateral component of the dilator response was greater in migraine sufferers than in control subjects, irrespective of the site of painful stimulation. The mechanism of this bilateral response is uncertain. However, a bilateral response to a unilateral stimulus suggests that the mechanism is not a simple reflex, but involves extensive central cross-over of afferent signals, or input from cortical or subcortical levels. Drummond (1995b) reported that loss of sympathetic vasoconstrictor tone increased the parasympathetic dilator response to strong gustatory stimulation. Migraine is associated with sympathetic deficit in facial blood vessels and the pupillary apparatus, primarily on the symptomatic side in patients with unilateral headache, but also contralaterally in some cases (Drummond, 1990, 1991; Chronicle and Mulliners, 1996). Thus, loss of sympathetic vasoconstrictor tone in facial vessels might amplify vasodilator responses to facial pain and headache.

Light-induced pain and associated responses such as blinking and lacrimation are probably mediated by interaction between trigeminal and visual input in the brainstem (Walsh and Hoyt, 1969). The eyes water to intense light in the absence of pain (Walsh and Hoyt, 1969), but the light used in the present study evoked lacrimation only during painful stimulation of the nasal ala. Irritating the cornea and the mucosal lining of the nose and mouth (e.g. with strong gustatory stimuli) causes reflex lacrimation (Walsh and Hoyt, 1969). Pinching the nasal ala with forceps irritated the mucosal lining of the nose; pain elsewhere in the head and neck was not an adequate stimulus for lacrimation, and did not prime lacrimation to bright light. It was not possible to determine whether more intense stimulation of the neck or facial skin would induce lacrimation, because the stimulus intensity was already at the subject’s pain tolerance level.

Lacrimal responses were smaller on the symptomatic than nonasymptomatic side in patients with unilateral headache. Studies of cardiovascular reflexes suggest that migraine may be associated with a mild parasympathetic deficit, although this is controversial (Thomsen and Olesen, 1995). Since lacrimation to facial pain is mediated by a trigeminal–parasympathetic reflex, the present finding is consistent with a local parasympathetic deficit on the symptomatic side in unilateral migraine (the afferent limb of the reflex appeared to be intact, as judged by symmetrical pain tolerances). Vascular responses to painful stimulation of the nasal ala did not differ between the symptomatic and nonsymptomatic sides in patients with unilateral migraine, possibly because the exaggerated bilateral component of the response overshadowed the ipsilateral (trigeminal–parasympathetic) component.

**Relevance of the present findings for the mechanism of migraine**

The findings suggest that migraine is associated with loss of inhibitory subcortical processes which normally suppress sensations of glare and light-induced pain, and which normally suppress the intensification of these sensations in the presence of facial pain. If so, headache and sensitivity to
light could increase in a vicious circle during attacks of migraine. Although not investigated systematically in the present study, the decrease in tolerance to painful mechanical stimulation of the face and neck during visual stimulation is consistent with this hypothesis.

Dilatation of pain-sensitized cranial arteries appears to be a major source of pain in migraine (Drummond and Lance, 1983; Iversen et al., 1990). Thus, facilitation of pain-related vasodilatation through central or peripheral loss of sympathetic vasoconstrictor tone, or vasodilatation through activation of trigeminal–parasympathetic reflexes or neurogenic inflammatory reactions (Moskowitz, 1984), might also increase headache.

The relevance of a trigeminal–parasympathetic reflex deficit on the symptomatic side in migraine is less clear. However, if this deficit includes the parasympathetic innervation of cranial blood vessels, then supersensitivity to the parasympathetic neuromodulator nitric oxide might form part of the migraine predisposition and amplify neurovascular responses during headache (Olesen et al., 1995).

Acknowledgements
I wish to thank Ms Roslyn Snyder for her technical assistance. This project was supported by a special research grant from Murdoch University.

References


Received January 28, 1997. Revised March 31, 1997. Accepted May 12, 1997