School of Psychology

The Relationship Between the Persistent Illusion of Movement and Traumatic Anxiety in a Non-Clinical Sample

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature: …….

Date: ……...

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Dedication

I dedicate this work to the memory of Amber Winsor, who loved and supported me from the start until almost the end. I will never forget all the beautiful memories you left behind.

Abstract

This thesis was concerned with investigating a visual-illusionary phenomenon that co-occurs with post-traumatic anxiety symptoms. More specifically, individuals who report recurring specific memories of a fearful event (RSM) also tend to report a persistent illusion of movement (PIM) upon prolonged visual fixation (Tym, Dyck & McGrath, 2000). The development of a visual test (i-Test) designed to reliably elicit PIM has enabled research to be conducted on the nature and correlates of this type of visual disturbance. The present research aimed: 1) To develop a standard protocol for assessment of PIM and RSM; 2) to test the reliability of the i-Test in eliciting PIM in a student sample 3) to test the predictive relationship between dissociation and anxiety symptoms with PIM and RSM 4) to formulate and test a hypothesis regarding a mechanism underlying PIM.

The first study screened 142 participants for RSM and PIM using self-administered questionnaires designed by Tym (personal communication, 2001). There was an unexpectedly high rate (54.2%) of PIM and RSM (37.3%) in the sample, which appeared to be the product of questionnaire design limitations. Two semi-structured interviews were developed and subsequently tested on a new sample of 50 participants in Study 2.

Study 2 documented intra-rater and inter-rater reliability co-efficient of sufficient strength to indicate good reliability for the semi-structured interviews. The results of Study 2 indicate that PIM is a relatively stable symptom over a 30-minute and one-week test-retest time frame. The onset time for PIM was relatively consistent between participants, with a mean latency of approximately 7 seconds. The oscillation rate of PIM was relatively consistent between individuals, with a mean average oscillation of approximately 0.8Hz.

The third study tested a sample of 148 participants using the revised assessment protocols. The base rate for PIM (16.2%) and RSM (18.9%), and the concordance rates (46% to 54%) were slightly stronger than the Tym et al. (2000) community based study (33%). In addition to this, 11 other illusionary phenomena were documented, however none of these visual symptoms significantly correlated with RSM. The average oscillation rate is comparable to the rate documented in Study 2, further establishing the consistency of the reported rate of PIM oscillations between individuals.

In Study 3, each participant was assessed for levels of dissociation (Dissociative Experiences Scale), somatic arousal (Mood and Anxiety Symptoms Questionnaire – Anxious Arousal Scale) and anxiety sensitivity (Anxiety Sensitivity Index). The results indicate that gender and dissociation significantly predict RSM status, and self-reported levels of anxious-arousal significantly

predict PIM status. A multiway frequency analysis between the sub-components of RSM and PIM revealed that the physiological arousal inducing properties of the recurring memory is the only significant predictor of PIM. The observed relationship between RSM and PIM may reflect the broader relationship between anxiety and dissociation.

A pulsatile hypothesis was proposed as a feasible mechanism underlying PIM, due to the rhythmical nature of the visual disturbance, the range of the documented oscillations, and its specificity to psychological disorders characterised by cardiovascular sensitivities. All participants were administered the i-Test prior to and following aerobic exercise aimed at increasing pulse rate to 80% of maximum load. An increase in physical exertion significantly increased the latency of PIM onset, but did not impact on the rate of PIM. PIM rate appeared relatively consistent between individuals at 0.6Hz to 0.8Hz at the pre-exercise condition. Several participants who reported PIM also displayed obvious nystagmoid-like movements during the i-Test perceptual task. The role of eye-movements in PIM requires further investigation by future ophthalmological research.

The final aim of Study 3 was to investigate the relationship between RSM/PIM and flicker sensitivity. Through the use of a Critical Flicker Frequency/Fusion task (CFF), each participant's sensitivity to flicker was determined. In addition

to detecting sensitivity thresholds, CFF is also considered to be a reliable indicator of the level of cortical arousal. The results of this study suggest that individuals with RSM have a higher sensitivity to flicker than other participants, however there was a non-significant relationship between CFF and PIM. The lack of relationship between PIM and CFF may be due to issues concerning statistical power and effect-size. Future research is required to investigate this link in more detail.

The overall results of this thesis suggest that i-Test elicited PIM is a reliable phenomenon that is associated with higher rates of traumatic memories when compared with persons who do not report this visual symptom. The strength of the association between RSM and PIM, however, does not support the use of the i-Test as a marker for the presence of RSM outside a clinical sample. The reliability of PIM as a phenomenon and its association with anxiety symptoms may be of theoretical importance in enabling future research to investigate the relationship between visual symptoms and anxiety-related pathology.

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Chapter 1

Introduction

1.0 Introduction to the Thesis Topic

Somatic aspects of anxiety disorders have been of central importance in understanding the processes that contribute to anxiety pathology, and in the development of effective treatments for anxiety disorders (Clark, 1986; Ham & Hope, 2003; Levitt, Hoffman, Grisham, & Barlow, 2003). Cardio-respiratory features of anxiety are perhaps the most widely researched somatic symptoms (Esler & Bock, 2004; Bass & Mayou, 2002; Aikens, Zvolensky & Eifert, 2001; Kroeze, van den Hout, 2000), however other sensory disturbances are also commonly reported concomitants of anxiety. In particular, visual disturbances remain one of the more commonly reported yet poorly understood symptoms accompanying anxiety states.

This thesis is concerned with a recent observation that a specific visual disturbance appears to be a reliable marker for a particular set of anxiety symptoms. More specifically, Tym, Dyck and McGrath (2000) claim that a persistent illusion of movement (PIM) can be elicited in people who report recurring specific memories (RSM) of a fearful event. Based on clinical observations of individuals reporting unsteady vision, Tym et al. (2000)

developed a visual test (named the i-Test) to detect this visual anomaly. Ninety percent of individuals in a clinical sample who reported an illusionary visual oscillation at steady gaze at the i-Test also reported recurring memories of a fearful event (RSM). RSM contains many similarities to re-experiencing symptoms in PTSD, which implies that persons with this disorder would report PIM more often than others. This was supported by the data from the Tym et al. (2000) study, in which every subject who met the formal diagnostic criteria for PTSD tested positive to the i-Test. Such a high concordance rate suggests that detection of PIM may have utility as a diagnostic marker for discriminating post-traumatic syndromes from other psychological disorders. However, the causes of these phenomena and the reasons why they tend to co-occur remain unknown.

The purpose of this thesis is to explore a proposed mechanism underlying PIM and to explain its observed concordance with RSM. The first chapter will review some known mechanisms responsible for causing illusionary movement in an effort to formulate a hypothesis on the mechanism underlying PIM. The first section of this chapter will review visual disturbances linked to nystagmus, the autokinetic phenomenon, dissociation, physiological arousal and the pulse-wave. The second section will review the nature of traumatic re-experiencing and other features of PTSD. It is expected that a review of the literature will highlight salient features common to visual instability and traumatic memories that can help explain the observed relationship between RSM and PIM. The

results of this research are expected to yield valuable information on how the visual system is related to traumatic memories. An understanding of this relationship may lead to the subsequent development of effective assessment and treatment techniques by taking into account visual symptoms in post-traumatic stress syndromes. It is first necessary to review the known properties of PIM so that established mechanisms for illusionary movement can be evaluated as possible causes for this disturbance.

1.1 Properties of PIM

Tym et al., (2000) described PIM as a persistent and rhythmical form of illusionary movement elicited by steady gaze at the i-Test stimulus. The i-Test is a black mat card (21cm X 30cm) with a yellow strip (1 X 5cm) placed centrally. A black fixation point is centrally placed 1cm from the top of the yellow strip. A positive response to the i-Test involves the persistent and rhythmical movement of the yellow strip over the black background upon steady gaze at the fixation point.

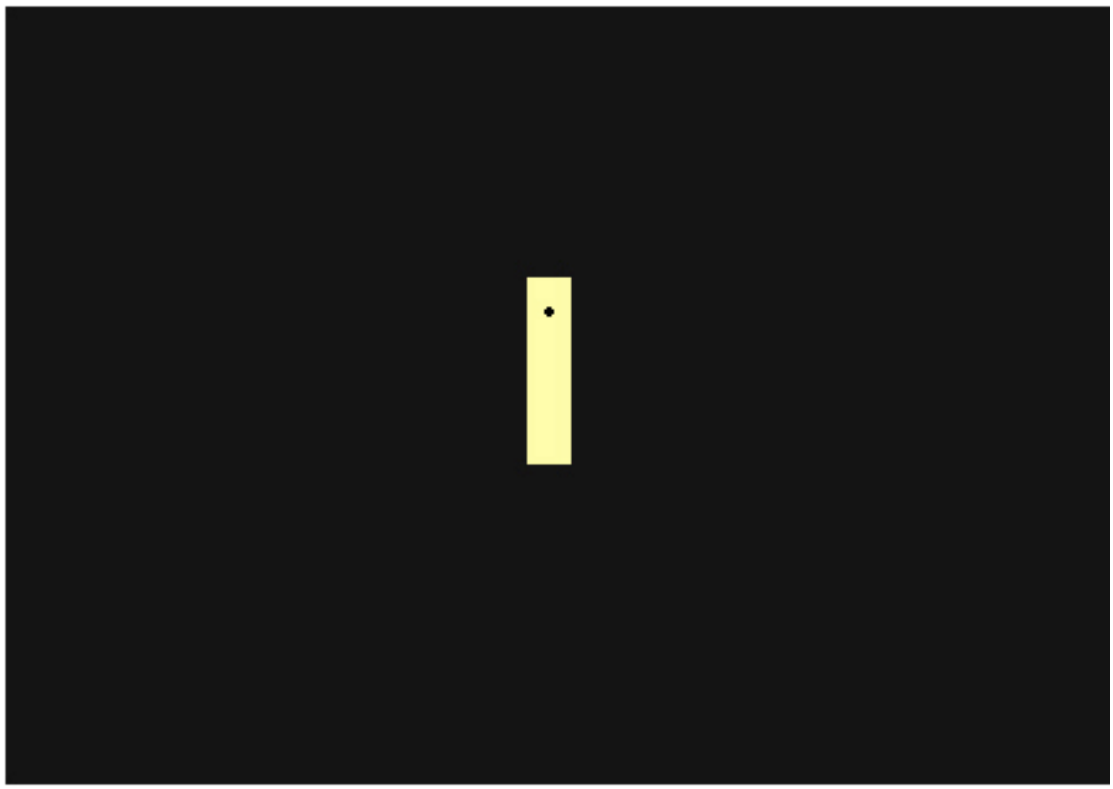

Figure 1. The i-Test.

Tym et al. (2000) described several distinct properties of PIM that differentiated it from other visual disturbances, and later provided more explicit detail of the characteristics of PIM described herein (Tym, Personal Communication, 2001).

1.1.1 Persistence

Once the illusionary movement is perceived, it persists for as long as steady gaze is maintained. The illusionary movement may be temporarily interrupted by blinking or head movement, but is resumed once steady gaze is re-established.

1.1.2 Onset

The illusionary movement usually appears within five seconds of steady gaze at the i-Test stimulus. The perception of illusionary movement must present within the first 30 seconds of steady gaze for a positive response.

1.1.3 Rhythmicity

PIM presents as a rhythmical movement of approximately 1 to 3hz in oscillation rate. Non-rhythmical, irregular or rapid movement (i.e. greater than 3Hz) is not considered to be of clinical significance.

1.1.4 Directionality

PIM tends to be described as a bi-directional movement. The disturbance typically presents as a movement across the horizontal plane. The amplitude of the disturbance increases with distance from the fixation point. Other forms of multidirectional movements still qualify as PIM positive as long as the criteria of rhythmicity and persistence have been met. Unidirectional drift of the central stimulus is not classified as PIM.

1.1.5 Unilateral or Bilateral Presentation

The illusionary movement may present in one eye or both eyes. There appears to be no difference in the clinical features of persons with unilateral versus those with bilateral disturbance. Unilateral PIM does not appear to be related to eye-dominance.

1.2 Diagnostic Correlates of PIM

Tym et al. (2000) did not investigate the genesis of PIM. However, they did examine the association between PIM and formal diagnostic categories of the DSM-IV in both clinical and community studies. Their results indicated that PIM was not unique to PTSD, but was associated with a range of diagnostic

categories (see Table 1). It is also important to note that all participants who met the diagnostic criteria for PTSD also reported PIM and RSM.

Table 1

Distribution of Participants in a Clinical Sample with Positive i-Test and RSM by Primary DSM-IV Diagnosis

DSM-IV DIAGNOSIS	A	B	C	D	E
Major Depressive Disorder	79	2	15	17	15
Dysthymic Disorder	24	0	3	3	5
Depressive Disorder NOS	10	0	1	1	2
Bipolar Disorder (I or II)	9	0	0	0	2
Cyclothymic Disorder	3	0	0	0	1
Panic Disorder With Agoraphobia	8	0	0	0	2
Panic Disorder Without Agoraphobia	6	0	3	3	1
Social Phobia	8	0	0	0	2
Obsessive Compulsive Disorder	2	0	0	0	0
Post-Traumatic Stress Disorder	10	6	4	10	2
Acute Stress Disorder	2	0	1	1	0
Generalized Anxiety Disorder	13	0	3	3	2
Anxiety Disorder NOS	14	0	6	6	3
Somatization Disorder	2	0	1	1	0
Pain Disorder	2	1	1	2	0
Eating Disorder	6	0	1	1	1
Adjustment Disorder	29	3	1	4	5
Personality Disorder	24	1	0	1	5
Schizophrenia (Paranoid)	10	0	2	2	2
Other Disorder	35	2	0	2	7
No Diagnosis of Disorder	5	0	0	0	1

Note: A = Full sample, n = 301; B = Males with positive i-Test and positive RSM, n = 15; C = Females with positive i-Test and positive RSM, n = 42; D = Males and Females with positive i-Test and positive RSM, n = 57; E = Number of subjects expected in each cell based on positive responders as a proportion of total sample (57/301). From Tym et al. (2000) p. 382.

Table 1 illustrates that both PIM and RSM are associated with a range of DSM-IV diagnostic categories in a clinical sample. A similar distribution across

diagnostic categories was observed in the community-based study, although a higher proportion of persons with Panic Disorder reported PIM in comparison to the clinical sample. The observed distribution of PIM and RSM across numerous diagnostic categories suggests that there may be underlying dimensions of psychopathology that are associated with visual instability. Examples of symptoms that are commonly reported by individuals with a range of disorders include dissociation (Michelson, June, Vives, Testa & Marchione, 1998; Kolb, 1989), anxious-arousal (Schmidt, Trakowski & Staab, 1997; Neal, Hill, Fox & Watson, 1999), and anxiety sensitivity (Peterson & Reiss, 1992; Cox, Borger & Enns, 1999). These symptoms have been independently linked to sensory disturbances (see sections 1.3 to 1.6) and thus can explain why visual instability occurs across a range of psychological disorders. What has yet to be demonstrated is whether PIM and RSM are associated with certain clusters of psychopathological symptoms rather than DSM-IV diagnostic categories. For example, if PIM is associated closely with arousal symptoms, then it would help to explain the concordance between PIM and RSM, and at the same time provide a reason why these two symptoms appear in various psychological disorders. It would also provide means to investigate the origin of the illusionary movement, as known arousal mechanisms (e.g., hyperventilation or cardiac arousal) can be empirically tested. Documented causes of visual instability will now be reviewed in order to highlight some possible mechanisms underlying PIM.

1.3 PIM as Oscillopsia

The properties of PIM described above appear to share many features with an ophthalmological symptom called oscillopsia. Oscillopsia was first described by Brickner (1936) as the illusionary movement of the visual world, and has been subsequently linked to anxiety pathology (Rees, 1959). In the ophthalmological literature, this symptom is most commonly associated with the absence of the vestibular ocular reflex (VOR), leading to difficulties with image stabilisation during systemic movement (Grunfeld, et al., 2000). The loss of VOR is usually the result of a lesion in the vestibular and related systems or from a degenerative neurological disease such as Multiple Sclerosis (Lopez, Kremenchutzky & Garcea, 1997). However, physiological arousal also appears to impact directly on VOR functioning (Furman & Jacob, 2001). Oscillopsia is typically associated with acquired nystagmus (AN) and is not usually reported in congenital nystagmus cases (CN) (Tkalcevic & Abel, 2003). In AN, oscillopsia is induced by head movements and minimised by head stabilisation (Grunfeld, et al., 2000). However, recent research has revealed that oscillopsia is evident in CN under specific conditions; for example Tkalcevic and Abel (2003) found that steady gaze at illuminated targets on a dark background tended to elicit oscillopsia in those with CN. There are approximately forty identified types of nystagmus, many of which have no clear cause (Cassin, 1995). Nystagmus induced oscillopsia shares some central features with PIM described by Tym et al.

(2000). For example, nystagmus can occur in one eye only or may occur in both eyes at different speeds (Cassin, 1995). More commonly, nystagmus manifests as symmetrical eye movements of constant speed from side-to-side at a oscillation rate of 1 to 10 Hz (Pickwell, 1989; Cassin, 1995).

Oscillopsia resulting from acquired nystagmus increases with speed and amplitude when the stimulus is presented in the periphery (Chung & Bedell, 1997), and is often associated with headache and over judging the location of a fixed point (Pickwell, 1989). Nystagmus is not a constant state, and may be induced by eye-strain, angle of viewing and specific drugs and alcohol (Von Noorden, 1990). Because individuals with this condition do not constantly display the symptoms, the routine assessment of nystagmus can be difficult. In some cases, oscillopsia gradually remits until it is no longer detectable, however in other cases it is persistent and disruptive to daily activities (Bronstein & Hood, 1987). The degree to which an individual adapts to oscillopsia appears to be largely mediated by psychological factors such as locus of control, optimism and anxiety-sensitivity (Grunfeld, et al., 2000).

Although the link between nystagmus and oscillopsia is well documented in ophthalmological literature, there have been relatively few investigations of psychogenic nystagmus. However, there have been documented observations of spontaneous nystagmoid movement in patients during the course of

psychotherapy (Teitelbaum, 1954) and in soldiers returning from war (Rees, 1959). Patients displaying these spontaneous eye-movements had no evidence of neurologic or ophthalmologic dysfunction, including organic nystagmus (Teitlebaum, 1954). These observations suggest a link between psychopathology, eye movements and oscillopsia, although it is difficult to determine the nature of this relationship.

Of particular relevance to this thesis topic is the research into the aetiology and correlates of what has been termed "miners' nystagmus" (Ferguson, 1943; Stern, 1948). Various explanations of the phenomenon have been offered over the last century, including exposure to toxic agents (Butler, 1939), postural factors (Reid, 1906), and inadequate illumination (Ferguson, 1939). It appears that a substantial proportion of miners presenting with this anomalous symptom reported the onset of nystagmus following a mining accident (Rees, 1959). Furthermore, idiopathic nystagmus has been documented in large numbers of "neurotic" soldiers returning from the Second World War (Rees, 1959). In both cases, over 80% of those presenting with nystagmus also reported high levels of anxiety and the illusionary movement of objects (i.e., oscillopsia). The exact mechanisms underlying the relationship between anxiety and nystagmus are unknown, and the reasons why it appears to be associated with posttraumatic conditions in these cases is equally puzzling. Unfortunately, research on this phenomenon has been scarce since Rees's (1959) investigation of emotional

factors associated with miners' nystagmus. Given that nystagmus is an established causal mechanism for oscillopsia, the observation of nystagmoid-like movements in persons who have witnessed an accident suggests that eye-movements may be the mechanism linking posttraumatic syndromes with PIM. Rees's observation that over 80% reported illusionary movement makes an explicit case for the role of eye-movements in PIM.

Tym et al. (2000) stated that the i-Test was developed out of informal experimentation to assess the presence of visual-perceptual disturbances in a clinical outpatient population. According to Tym et al., these disturbances "… could not be accounted for by known abnormalities of the visual system, astigmatism, detectable movement (abnormal or otherwise of the eye, head, or body, including central nystagmus), neuro-ophthalmologic, or systemic disorder." (p. 380). If PIM cannot be attributed to either abnormal or normal movement of the eyes, then nystagmus is not a plausible mechanism. However, it is not clear by which methods eye-movements were investigated, nor how many individuals with PIM were screened for neuro-ophthamologic conditions as part of this informal experimentation. Data were not recorded on the occurrence of visual abnormalities in the Tym et al. (2000) studies. Given the strong evidence that nystagmus is a cause of visual instability, and that similar eye-movements have been observed in persons after witnessing an accident, the role of eye-movements in the genesis of PIM requires further investigation. To

adequately review possible mechanisms underlying PIM, other documented forms of illusionary movement will be discussed.

1.4 PIM as a form of the Autokinetic Phenomenon

One of the most well documented forms of illusionary movement is the Autokinetic Phenomenon (AP) (Borresen, 1982). AP had been documented as early as 1799 by von Humboldt, who found that prolonged gazing at a point of light in an otherwise dark environment tended to result in an illusionary drift (Toch, 1962). Although this is the most common paradigm used to induce AP, Honisett and Oldfield (1961) found that fixation on a single point in a complex visual field can elicit autokinetic movement in some individuals. Rock (1997) further stated that the dark-room setting represents a convenient and standard way of eliciting AP, but that other experimental conditions could elicit the illusion. A well-defined fixation point on any homogenous black background appears to be the specific requirements necessary to elicit AP (Rock, 1997). The i-Test stimulus used to elicit PIM in the Tym et al. (2000) study is similar to the standard paradigm used to elicit AP, as the fixation points are presented on homogenous black backgrounds. This suggests that PIM could be a form of the Autokinetic Phenomenon.

There appears to be a large range of individual variation with AP, ranging from extensive and multi-directional drift of the light to no illusionary movement

reported at all (Rock, 1997). The large individual variation in the quality and extent of the AP led Voth (1947) to hypothesise that the illusion may discriminate between psychiatric conditions. The predominant view of the time was that mental illness was essentially derived from deficiencies in personality structure, and that projective testing was the most effective way of detecting such deficiencies. Voth's main theoretical basis for the discriminant validity of the autokinetic phenomenon was that the task itself acts as a form of projective personality testing. This was suggested to be the reason for the large individual differences in the autokinetic phenomenon and the static nature of the illusion within individuals over time. Voth found moderate rates of movement were associated with schizophrenia, epilepsy, psychasthenia, neurasthenia, and anxiety states. Another important finding was that the illusionary movement was significantly reduced or returned to normal after successful treatment of the psychiatric symptoms. This suggests that the mechanisms underlying the perceptual distortions are linked to the mechanisms underlying dimensions of psychopathology.

In order to test whether central or peripheral mechanisms were responsible for AP, Singh and Singh (1961) tested the effects of CNS stimulants and depressants on the illusion. They found that stimulants increased the autokinetic latency (i.e., the time taken for the illusionary movement to initiate) and depressants had the opposite effect. Whilst Singh and Singh speculated that the increase in latency

was related to cortical arousal versus satiability, the exact mechanisms responsible for the effect were not empirically tested. Current explanations of the AP incorporate both peripheral and central mechanisms in the generation of illusionary movement (Rock, 1997). It is important to note that Singh and Singh's research implicates the role of cortical arousal in AP. If such an effect is consistent, it implies that the level of cortical arousal impacts on visual stability, which might help explain PIM.

Of the several proposed explanations for the AP, the Outflow Model (or Efference Copy Model) appears to have the most empirical support (Rock, 1997; Hoyenga & Wallace, 1982). This model proposes that the illusionary perception of movement in the AP arises from disruptions in the central monitoring of eye-movements. In conditions where eye movements are not centrally registered, unintended eye-drifts are incorrectly attributed to external movement (Rock, 1997). There is substantial evidence that eye-drifts are evident in those experiencing the AP (Leibowitz, Shupert, Post, & Dichgans, 1983; Pola & Martin, 1977; Hoyenga & Benjamin, 1978). The disruption in monitoring afferent and efferent motor signals has been attributed to a range of factors such as fatigue (Hoyenga & Wallace, 1978), personality characteristics (Farley & Peterson, 1974), gender (Chaplin, 1955) hypnotic susceptibility (Wallace & Garrett, 1973), psychopathology (Schlossberg & Rattok, 1974), physiological mechanisms (Royce, Carran, & Aftanas, 1966) and drugs (Moskowitz & Sharma,

1974). There appears to be a range of factors that may disrupt the system's ability to effectively monitor sensory-motor signals leading to perceptual anomalies in the Autokinetic Phenomenon. However, what is clearly understood is that AP only arises under specific environmental conditions in which the fixation point lacks contextual references in the visual field (Rock, 1997).

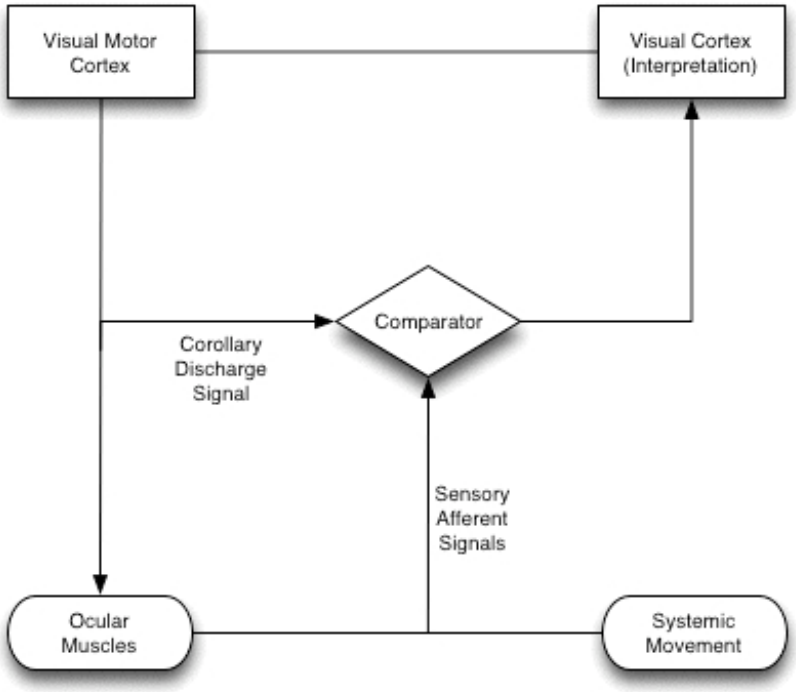

Figure 2. *Outflow Model of Ocular Stability. Schematic representation of the outflow theory of eye movements. Adapted from Schiffman (1990) page 319.*

In the Outflow Model, efferent motor signals are effectively duplicated in the form of a Corollary Discharge Signal and stored in a central Comparator. Afferent signals from the ocular muscles feed back to the Comparator and are matched to the original Corollary Discharge Signal. Any discrepancy between centrally generated motor command and the feedback afferent signal results in

the perception of external movement. The Comparator receives afferent information from systemic and vestibular systems in order to take into account other forms of centrally generated movement.

The Outflow Model is useful in explaining the origin of visual disturbances, especially those in which illusionary movement is perceived. If illusionary movement is related to eye-movements, then the disturbance is likely to originate from either central afferent failure to monitor eye movements or external agents (Rock, 1997). However, if eye-movement is absent or does not correspond to the illusionary movement, then central processes related to the generation of efferent ocular-motor signals are the likely origin of the disturbance.

The possibility of PIM being a form of oscillopsia or the AP is unlikely if eye-movements have been completely ruled out. If this is the case, it is still possible that PIM may be the result of disrupted ocular-motor commands that would normally result in eye-movement, but which under conditions of visual fixation, are inhibited. In this scenario, motor commands registered at the comparator that do not correspond to afferent sensory signals would result in PIM. Such an explanation for PIM would be difficult to verify through experimental testing, as many parts of the outflow model cannot be directly observed or manipulated. However in the absence of eye-movements, a central mechanism such as cortical arousal proposed by Singh and Singh (1961) may play a role in the illusionary

movement. If a relationship exists between cortical arousal and PIM, then it would lend support to the notion that PIM is a form of the autokinetic phenomena. The mechanism responsible for the generation of rhythmical and persistent ocular movement still needs to be considered.

1.5 PIM Related to Pulsatile Movement

The outflow model postulates that the central monitoring of eye-movements also gains input from systemic and vestibular sources. This implies that bodily movement must be centrally accounted to effectively maintain ocular stability. A further implication is that systemic movement may cause visual instability if the system's capacity to compensate for this source of movement is compromised. This leads to the questions: 1) What conditions lead to visual instability? and 2) What is the source of systemic movement that accounts for the properties of PIM?

In this thesis, it is proposed that the visual system's ability to maintain ocular stability can be compromised during cardiovascular arousal. It is known that the cardiovascular system and visual systems are closely related. The retina, for example, is metabolically active tissue and is highly sensitive to small changes in blood flow (Hix, Reingold & Hammond, 2002). Ocular vasoconstriction can result in reduced visual acuity, blurriness and visual distortions (Cameron & Ryan, 1997). Arterial hypertension can result in increases in intraocular pressure

(Leske & Podgor, 1983) and can have a significant impact on visual performance (Langham, 1994). The sensitivity to flicker is also significantly related to ocular hypertension, and when intraocular pressure is artificially increased, a reciprocal reduction in flicker sensitivity results (Tyler, 1981; Vo Van Toi, Grounauer & Burckhardt, 1990).

These findings support the notion that cardiac changes can impact directly on visual functioning. However it does not explain whether such changes can account for PIM. Although there is no clear evidence that pulsatile movement can lead to visual instability, it has been directly linked to aural disturbances. Pulsatile tinnitus, for example, is described as a persistent aural disturbance occurring in synchrony with the pulse rate (Sanchez, Sennes & Bento, 1999). At the very least, the occurrence of pulsatile tinnitus establishes that the pulse-wave is capable of producing rhythmical sensory disturbances. The notion that the pulse-wave could underlie PIM is supported by two observations. Firstly, the frequency of pulse-wave encompasses the documented range of PIM (i.e., 1 to 3Hz). Secondly, the pulse-wave in physically healthy individuals is rhythmical and persistent, which are the two key features of PIM. As mentioned earlier, the visual system is sensitive to small changes in blood flow (Hix et al., 2002), which supports the notion that pulse-wave could result in corresponding ocular movements. It is proposed that the i-Test perceptual task provides a set of environmental conditions by which these subtle changes in vision are noticeable.

For example, ocular movement from systemic sources may be offset during voluntary eye-movements but not during fixation. Likewise, a homogeneous background lacks contextual cues facilitating visual instability as a result of unintended ocular movement (Rock, 1997).

If PIM is linked to pulsatile movement, then the question arises of why the pulse-wave only leads to perceptual instability in some individuals and not others. This can be explained by the relationship between cardiovascular sensitivity and anxiety pathology documented in the literature. For example, it has been demonstrated that individuals with high anxiety sensitivity display a greater somatic acuity towards pulse transit-time than normal controls (Richards & Bertram, 2000). Vigilance towards cardiovascular symptoms has been a widely accepted component to the panic cycle (see Clark, 1986), and has been proposed to play a role in anxiety pathology. In addition to this, the effects of physiological arousal are an important part of anxious states, and often form the stimuli feared by persons with anxiety pathology. Of these feared stimuli, cardiovascular symptoms often dominate (Pennebaker & Watson, 1991). This suggests that individuals who are internally preoccupied and fear cardiovascular symptoms and more likely to notice cardiovascular changes (Clark, 1986; McNally, 1999). Further from this, it is proposed that specific subsets of anxious individuals are prone to notice the visual impact of cardiovascular movement. The reasons for some individuals to be visually sensitised may relate to the

specific aetiology contributing to their anxious state. These individuals may experience visual distortions during extreme anxiety states (e.g., during panic or witnessing a traumatic event), and as a result become sensitive to noticing subtle changes in visual perception on subsequent occasions. The occurrence of visual distortions during heightened anxiety states are often referred to as derealization (DR). The notion that PIM forms a part of the DR experience will now be discussed.

1.6 PIM as a Derealization Symptom

In the clinical literature, perceptual disturbances are typically conceptualised as some form of Depersonalization/Derealization experience (DP/DR) (Steinberg, 1995). DP/DR describes a state in which the individual experiences perceptual disturbances and perceives him/herself or the external world as being "unreal" (American Psychiatric Association, 1994; Steinberg, 1995). DR often involves perceptual distortions of external objects or people, leading to difficulties in recognition (Steinberg, 1995). For example, perceptual distortions in size (macropsia/micropsia) and viewing the external world through a diffuse "mist" or "fog" are commonly reported visual disturbances that are typically considered part of a DR experience (American Psychiatric Association, 1994). These visual symptoms are often considered to be distinct phenomena from the subjective perception of unreality, even though they tend to co-occur. For example, hypoxia induced perceptual changes often lead to a perception that the external

environment is unfamiliar or unreal (Papp & Gorman, 1995; McNally, 1994; Van Diest et al., 2000). In this respect, the subjective experience of unreality is the result of the interpretation of anomalous sensory experiences.

Distortions of shape, colour and form are commonly reported accompanying heightened anxiety states. An example of this is in an early study by Deikman (1966a), in which research participants were required to gaze at a blue vase for prolonged periods of time. One subject reported "…solid material such as myself and the vase and the table seems to be attributed then with this extra property of flexibility such as in its natural, fluid state" (1966a, p. 113). There are occasional reports in the literature pertaining to illusionary movement in DR states, such as the following description by Castillo (1990, p. 2): "Sometimes, normally stable, solid, inanimate objects may be seen to vibrate, or "breathe", to be unsolid, fluid or alive". This description clearly implicates the perception of movement in the visual field. As DR experiences are often described idiosyncratically, it is difficult to know what features of reported perceptual disturbances are common to DR.

Dissociative phenomena have been observed in a wide range of psychiatric conditions, including PTSD, Schizophrenia, Depression, Panic Disorder and Dissociative Identity Disorder (Steinberg, 1995). Descriptions of DR commonly include visual disturbances of the external environment induced by a heightened

state of anxiety (Miller et al., 1994). It has been observed that many individuals experience the derealization as part of a set of complex symptoms commonly labelled the "phobic anxiety-depersonalisation syndrome" (Ambrosino, 1973; Shraberg, 1977). However, it remains unclear as to whether DR causes heightened anxiety states, or whether the anxiety precedes the DR symptoms. Individuals with high levels of DR have been found to have high levels of anxiety, and individuals with high levels of anxiety have been found to exhibit more DR symptoms (Trueman, 1983). Both PIM and dissociative experiences are found across a range of psychological disorders and are especially found in high rates amongst persons with PTSD. This similar distribution supports the notion that PIM may relate directly to DR.

Several explanations of DR have been proposed, including altered brain-states (Timsit-Berthier, de Thire, & Timsit, 1987), disturbances in perceptual-affective recognition (Siomopoulos, 1972), disintegrative attention (Reed, 1988), and disassociated cognitive systems (Hilgard, 1994). Most of these models have focused their attention towards explaining the perception of unreality rather than the occurrence of visual-perceptual phenomena. Recent cognitive-behavioural conceptualisations of DP/DR have drawn upon predominant models of panic (Clark, 1986) and health anxiety (Warwick & Salkovskis, 1990) in order to explain the persistence of DP/DR in specific psychopathological conditions (Hunter, Phillips, Chalder & Sierra, 2003). Whilst cognitive models of panic

have emphasised the misinterpretation of cardio-respiratory symptoms in the production of panic (e.g., "I am having a heart attack"), DP/DR symptoms are more likely to be interpreted as a sign of cognitive dyscontrol (e.g., "I am losing my mind") or a fear of organic brain disease (e.g., "I have a brain tumor"). According to the model of Hunter et al., DP/DR symptoms can be induced by a range of factors including trauma, fatigue, anxiety, depression, panic and drug intoxication. In cases where the DP/DR symptoms are attributed to situational factors or transient states, the symptoms tend to resolve. However, the catastrophic interpretation of DP/DR as a indicator of impending insanity leads to an increase in anxiety, which in turn increases the susceptibility of experiencing further DP/DR symptoms (Hunter et al., 2003). Indeed, the occurrence of DP/DR can act to reinforce this belief (e.g., "I know I'm mad because I just saw the colour of objects around me change"). People who develop persistent DP/DR may have a pre-morbid concern about their vulnerability to developing a mental illness, which predisposes them to make catastrophic interpretations of anomalous experiences (Simeon & Hollander, 1993; Hunter et al., 2003). If PIM is linked to an anxious-arousal state, then persons with such catastrophic interpretations are likely to respond differently to the illusionary movement (i.e., to report DP/DR). A review of techniques used to induce DP/DR in an experimental setting may highlight similarities between these methods and methods used by Tym et al. (2000) to elicit PIM. If similar

techniques for inducing PIM and DR are evident, it would lend further support to the notion that PIM forms part of the DR experience.

1.6.1 Methods for Inducing Derealization

Methods for inducing DR range from drug intoxication (Krystal, et al, 1994), fatigue (Reed, 1988), and hyperventilation (Papp & Gorman, 1995; McNally, 1994; Van Diest et al., 2000). One of the less commonly cited methods for inducing dissociative perceptual disturbances is the use of steady-gaze techniques. An example of this method is in research by Miller and colleagues (1993), who found that steady gaze at a mirror image or a fixed dot on a wall induced depersonalisation (DP) and DR in both clinical subjects and normal controls. It was also found that visual disturbances elicited by steady gaze at a dot on the wall precipitated a fear reaction in a number of subjects in the clinical sample. Steady gaze also tends to elicit the illusionary perception of movement in Autokinetic Phenomenon (Hoyenga & Wallace, 1979) and other anomalous forms of visual instability (e.g., PIM in Tym et al., 2000). The eliciting of these visual symptoms by steady gaze suggests that there are specific perceptual processes that are either initiated or inhibited under these conditions. The precise nature of these processes is not fully understood, though it is speculated that steady gaze may evoke sensory deprivation conditions leading to perceptual distortions (Evans & Piggins, 1963). The benefit in using this technique is that subjects are not able to clearly attribute their perceptual experience to an

externally induced state (such as hyperventilation or drug intoxication), making their perceptual experience more likely to elicit an anxiety response. Steady gaze procedures are used to elicit PIM, which supports the notion that PIM is a marker for underlying dissociative processes. If RSM is also a form of DR, then the relationship between PIM and RSM may be attributed to common dissociative mechanisms. However this explanation would only extend to the relationship between RSM and PIM, leaving the mechanism underlying PIM undetermined. It may be the case that physiological arousal accompanying DR causes the perceptual instability in PIM and that the subjective sense of unreality ensues.

1.7 Visual Disturbances and Hyperventilation

There has been extensive documentation of visual-perceptual changes resulting from physiological arousal occurring in anxious states. Some perceptual changes related to hyperarousal can be directly attributable to hyperventilation and associated hypocapnia, cerebral hypoxia and respiratory alkalosis (Van Diest et al., 2000; Van Der Molen, et al., 1988). Hyperventilation can result in the subjective experience of dizziness, disorientation, blurred vision (McNally, 1994), and derealization (Papp & Gorman, 1995; McNally, 1994; Van Diest et al., 2000). Hypocapnia induced visual disturbances include cloudy vision, tunnel vision, total loss of vision and flashing lights (Lum, 1975; Taylor, 2000). Taylor (2000) suggests that the common occurrence of visual "brightening" during high anxiety states is due to hypocapnia-related pupil dilation, and "greying out" is the

result of vasoconstriction in cerebral hypoxia. The secondary physiological process of respiratory alkalosis acts to increase the excitability of neurons causing tingling sensations (Van Diest et al., 2000) and an increase in flicker sensitivity (Alpern & Hendley, 1952).

It is known that hyperventilation is a common response to stressors (McNally, 1994), suggesting that visual-perceptual distortions that occur at the time of a traumatic incident may be related to respiratory mechanisms. Although it is known that breathing during sleep is altered in PTSD (Karkow et al., 2001; Youakim, Doghramji & Schutte, 1998), it is unclear whether persons with this disorder display a differential response to hypocapnia induced perceptual changes compared with normal controls. Although there are a number of documented visual anomalies associated with hyperventilation, the illusionary movement is not commonly reported. It would be expected that experimental induction of hyperventilation would have at least produced some evidence that illusionary movement is associated with this physiological state. As this has not been the case, it is unlikely that PIM is associated with the cluster of visual disturbances induced by hyperventilation. There may be other processes associated with arousal that better explains the genesis of PIM.

1.7.1 Arousal and Flicker Sensitivity

As aforementioned, the autokinetic phenomenon appears to be affected by cortical arousal. What is also relevant to this topic is the observation that an increase in cortical arousal leads to perceptual instability (Coren, 2002). In particular Coren found that caffeine increases cortical arousal and leads to a greater degree of perceptual instability in the visual field. He documented that participants reported visual-perceptual instability during steady gaze at a grid line stimulus after consuming 100 or 200 milligrams of caffeine. Increasing dosages of caffeine were associated with greater visual instability, which Coren suggested was the result of increasing levels of cortical arousal. An implication of this research is that visual instability may be an effective way of easily assessing the level of cortical arousal in a number of contexts (Coren, 2002). This finding is relevant because it also suggests that arousal of central rather than peripheral mechanisms can result in perceptual instability.

An established way to gauge levels of cortical arousal is by the use of critical flicker/fusion frequency (CFF) paradigms (Curran, 1990; Bobon et al., 1982; Malfara, 1971; Nettleback, 1972). CFF is described as the point at which successively presented lights are no longer perceived as flickering, but rather appear to be a continuous and steady image (Amir & Ali, 1989). CFF is generally considered to be determined post-receptorally and is a holistic index of

visual functioning (Hix, Reingold & Hammond, 2002). For instance, animal studies indicate that CFF thresholds were determined by activity in the cells of areas 17 and 18 of the primary visual cortex (Wells et al., 2001). The relationship between arousal and CFF has been established in several studies, including Malfara (1971), who found that CFF was an effective instrument in detecting levels of conditioned anxiety. Through the use of electric shocks, Malfara found that CFF best discriminated between low levels of arousal. This is further supported by Bobon and colleagues (1982), who suggested that CFF is a useful measure of anxiety as well as other forms of psychopathology, such as depression and hysteria. Furthermore, early research into CFF and Central Nervous System (CNS) excitability established that stimulants characteristically increase CFF thresholds and depressants decrease thresholds (Simonson & Brozek, 1952; Smith & Misiak, 1976). CFF is also highly correlated with electroencephalographic (EEG) measures of cortical arousal (Grunberger et al., 1992) and self-reported levels of arousal (Grandjean et al., 1977). Although numerous studies have found a positive correlation between CFF and anxiety levels, other studies have reported an inverse relationship. Later reviews of earlier research have attributed the contradictory findings to differences in the apparatus used to measure CFF (Amir & Ali, 1989). The current status of CFF as an index of cortical arousal is that it is widely accepted (Corr, Pickering & Gray, 1995).

One of the more relevant studies in the area of CFF and anxiety was in early work by Krugman (1947). He claimed that CFF could effectively discriminate between normals and psychoneurotics, and stated that CFF could be used to measure "roughly yet objectively, the degree of disturbance possessed by various individuals…" (Krugman, 1947, p. 269). Krugman used a sample of World War II servicemen who presented with neurotic-like or operational fatigue symptoms including severe anxiety and hypertension. Given the symptoms evident in these servicemen, it is highly likely that the psychoneurotic syndrome discussed by Krugman was synonymous with posttraumatic syndromes. He found that CFF was inversely related to anxiety level, which was consistent with later studies concerning flicker sensitivity and psychoneurotic anxiety (Goldstone, 1955; Wagoner, 1960). However, several studies around the same time found no significant difference in the level of anxiety and CFF thresholds (Riccituti, 1947; King, 1962). Isaacson, Hutt and Blum (1967) suggested that these discrepant findings may be the result of a broad definition of psychoneurotic anxiety which incorporated mild symptoms of restlessness to intense physiological and psychological disturbances, including fatigue, difficulty sleeping, depression and headache. Similarly, Malfara (1971) offered the explanation that a threshold of severity of anxiety symptoms needed to be reached before perceptual impairments become evident. Krugman's (1947) investigation of CFF did not examine which symptoms of the psychoneurotic syndrome best accounted for changes in flicker threshold. It is possible that war-servicemen exhibited re-

experiencing symptoms along with other features of post-traumatic anxiety that may have impacted on CFF thresholds but were not accounted for.

Whilst CFF is widely used in the literature as an established index of fatigue (see Amir & Ali, 1989), its use in clinical research has remained limited, perhaps due to the conflicting results in early studies. Future research needs to address some of the design issues that confounded earlier studies in order to gain a clearer understanding of the relationship between CFF and traumatic anxiety. However, CFF does provide a useful measure of cortical arousal. This may be relevant in investigating the origins of PIM, if the visual instability is directly related to levels of cortical arousal. If RSM is also associated with increases in cortical arousal, then this mechanism can explain why the two symptoms co-occur. A review of the properties of RSM is necessary to ascertain whether there are other shared features between PIM and RSM that could explain their concordance.

1.8 Properties of RSM

Tym et al. (2000) proposed that the PIM found in people with PTSD is related specifically to an abnormal form of memory. They identified a recurring and specific memory of a fearful experience (RSM) that had the following properties: (a) memories have been accessible since the fearful event; (b) recall can be spontaneous, voluntary or cued; (c) the fearful memories are of an unspecified

intensity; (d) the memories are of great clarity which leads to a sense of recency; (e) recall is always accompanied by subjective and somatic fear (Tym et al., 2000).

There are three key features of RSM that may explain the link between this memory symptom and PIM. The first key feature is vividness, where the fearful memory is recalled with great clarity leading to a sense of recency. This feature has been documented in the literature on re-experiencing symptoms, in which traumatic memories are described as temporally distorted and highly vivid recollections of the event(s) (Hellawell & Brewin, 2002; Clark & Ehlers, 2000). It is unknown whether this feature of RSM is the most salient link between this memory symptom and PIM. Another key feature of RSM is the presence of persistent somatic and subjective anxiety (Tym et al, 2000). This consists of physiological aspects of arousal as well as the cognitive and emotional components of anxiety. Tym et al. (2000, p. 381) further emphasise "…that although affects other than fear may be present, unless fear is present, the memory does not constitute experiential recall". This implies that all individuals with RSM experience anxious-arousal, irrespective of their primary DSM-IV diagnosis. This being the case, the high concordance between RSM and PIM could be due to common anxious-arousal mechanisms. The relationship between anxious-arousal and PIM is yet to be empirically tested.

1.8.1 Traumatic Memory Characteristics in Anxiety Pathology

As discussed earlier, anxious arousal is a necessary component of RSM, and the same anxious-arousal process can result in visual-perceptual disturbances. However, the possibility that the vivid property of RSM could lead to PIM needs consideration. To gain some understanding of how RSM is linked to PIM, the nature of traumatic memories in PTSD require consideration. Traumatic memories in PTSD appear to be a sensory rather than autobiographical experience (Ehlers & Clark, 2000). This is supported by evidence that visuospatial performance is reduced during a re-experiencing episode, suggesting some type of competition for limited visuospatial resources (Hellawell & Brewin, 2003). Another key feature of traumatic memories is that they are more likely to be triggered by perceptual cues rather than semantic ones. An example offered by Ehlers and Clark (2000) from a patient "who had been involved in a car crash at night noticed that a patch of bright sunlight on his lawn triggered vivid intrusions of headlights coming towards him" (p. 326). The form of the perceptual stimuli need only to bear a vague resemblance to those experienced at the time of the initial trauma in order to trigger a re-experiencing episode (Ehlers & Clark, 2000). Furthermore, individuals with PTSD have a reduced perceptual threshold for detecting stimuli that are temporally associated with the original traumatic event (Ehlers, et al., 2002). As the high incidence of peri-traumatic DR in people with PTSD has been documented by other authors (Ehlers, Mayou, & Bryant, 1998; Murray, Ehlers & Mayou, 2002), the occurrence of perceptual

disturbances at the time of the trauma may form a perceptual trigger for further re-experiencing episodes. What this might suggest is that persons who experience recurring traumatic memories may be more visually sensitive due to the reduced perceptual threshold. If we assume that persons with RSM are similar, then the reduced perceptual threshold may extend to detecting small eye-drifts and other forms of ocular movement that are normally sub-threshold. The misattribution of eye-movement as environmental movement could underlie PIM, and is the same process that underlies organic oscillopsia and the AP.

Tym et al. (2000) defined RSM as a vivid fearful memory that can be cued, spontaneous or voluntarily. This differs from re-experiencing in PTSD, which is characterised by a pattern of vivid involuntary recall of the trauma, and vague intentional recall of the same trauma (Hellawell & Brewin, 2002; Clark & Ehlers, 2000). During intentional recall, persons with PTSD tend to report fragmented, disorganized and vague accounts of the events (Ehlers, Hackmann, Steil, Clohessy, Wenninger & Winter, 2002; Clark & Ehlers, 2000). However, during re-experiencing, vivid details of the trauma are experienced as if they were happening in the present. An explanation of this apparent contradiction is that traumatic memories are not sufficiently processed and therefore not available for voluntary recall (Hellawell & Brewin, 2003; Ehlers & Clark, 2000). The “as if” quality of re-experiencing is thought to be due to the absence of autobiographical processing, which by nature is a temporally organised system of

recall (Ehlers & Clark, 2000). This type of temporal distortion is not evident in normal autobiographical accounts of trauma (Hellawell & Brewin, 2002).

The literature suggests that vivid re-experiencing of a trauma is a perceptual experience that results in concurrent deficits in visual-spatial processing. However, it is not clear how this feature of RSM could account for the various properties of PIM (in sections 1.1.1 to 1.1.5). For example, the question of how competition for visual-spatial resources results in rhythmical and persistent illusionary movement is difficult to answer. However this cannot be ruled out prior to investigation. For example, vivid and temporally distorted memories of a fearful event could result in spontaneous eye movements. This type of eye movement could be similar to that documented by Rees (1959), and result in the perception of illusionary movement (i.e., PIM). The relationship between "vividness" and PIM needs to be established before such a mechanism can be proposed.

The vivid and temporally distorted qualities of traumatic memories have often been described as dissociative phenomena (Speigel & Cardena, 1991; Steinberg, 1995). The relationship between dissociation and re-experiencing will now be reviewed in order to establish whether dissociative processes could account for the relationship between RSM and PIM.

1.8.2 Dissociation and Re-experiencing

DR is a central feature of PTSD (Speigel & Cardena, 1991). The most common manifestation of DR is in the "flashback" phenomenon, in which occurs a "reliving of the past as though it were occurring in the present." (Speigel, 1984, p. 522). The temporal regression and perceptual aspects of the flashback experience have lead to its classification as a form of DR (Speigel & Cardena, 1991). DR is also prevalent in the general population, with many reports of perceptual disturbances occurring in response to acutely stressful situations. In fact, Noyes and Kletti (1977) found that 81% of subjects who reported experiencing real threat to their mental or physical integrity also reported DR. This high rate of DR suggests that dissociation has a particularly important link to trauma reactions, and that symptoms associated with DR are often present at the time of the initial trauma. An example of the link between trauma and DR is evident in a case described by Steinberg (1995) in which a subject reported that surrounding "colours just popped out" during an episode of sexual abuse as a child (p. 150). Dissociation occurring at the time of the traumatic event (i.e., peri-traumatic dissociation) has been found to strongly predict the later development of PTSD (Ehlers, Mayou, & Bryant, 1998; Murray, Ehlers & Mayou, 2002).

Whilst cognitive models acknowledge that dissociation is a predominant feature of PTSD, the role of dissociation in the maintenance of other psychopathological

symptoms remains unclear (see Ehlers & Clark, 2000). Rather than implicate dissociation as a perpetuating factor per se, Ehlers and Clark suggested that DP/DR may "impede the elaboration of the trauma memory and its integration into the autobiographical memory knowledge base." (p. 130). However, the exact process by which dissociation interferes with proper memory encoding is not clearly delineated, other than that it may be associated with data driven processing (Halligan, Clark & Ehlers, 2002) and is implicated in the fragmented nature of traumatic memory recall (Ehlers & Clark, 2000). The role of dissociation in PTSD could be important considering the common reports of DR during peri-traumatic dissociation (Noyes & Kletti, 1977), which suggests that these disturbances may form the perceptual stimuli that may later trigger re-experiencing episodes.

The question of whether RSM is associated with dissociation remains untested. If RSM is associated with similar increases in dissociation as re-experiencing in PTSD, and PIM is also related to similar increases, then it can be assumed that both symptoms are symptomatic expressions of the same underlying construct. That is, RSM and PIM are linked through dissociation. However, dissociation as a construct is more descriptive than explanatory, and is limited in determining the genesis of PIM. As previously discussed, arousal processes are established mechanisms underlying numerous visual disturbances experienced during

heightened anxiety states. Whether such processes are necessary components of traumatic memories needs to be established.

1.8.3 Arousal and Posttraumatic Anxiety

Persistent hyperarousal is characteristic of PTSD (American Psychiatric Association, 1994). The role of hyperarousal in the maintenance of other symptoms of PTSD has received recent attention (Nixon, Resnick & Griffin, 2002). In particular, the occurrence of peri-traumatic panic has been found to be highly predictive of later development of intrusive symptoms in PTSD (Resnick, 1997). It appears that high levels of arousal at the time of the trauma coincide with reports of peri-traumatic dissociation, which may be explained by the broader relationship between arousal and dissociation (Bernat et al., 1998). Furthermore, significant proportions of individuals with PTSD report panic following the traumatic incident (Falsetti & Resnick, 1997), and those individuals diagnosed with PD often report traumatic incidents in the past (David, Giron & Mellman, 1995).

Re-experiencing episodes are characterised by a heightened state of anxiety (Woodward, Murbug & Bliwise, 2000). The level of arousal during the re-experiencing phenomenon is so marked that it has led some researchers to believe that it is a form of panic (Mellman & Davis, 1985). This notwithstanding, it is well accepted that heightened physiological arousal is a

predominant feature of the flashback experience (American Psychiatric Association, 1994). Furthermore, there is evidence that individuals with PTSD display high baseline levels of arousal outside of the flashback experience (Woodward, Murbug & Bliwise, 2000).

If it is assumed that RSM shares some common features with traumatic re-experiencing in PTSD, then arousal could play an important role in the generation of both RSM and PIM. If the persistent levels of baseline arousal observed in persons with PTSD are extended to persons with RSM, then it would account for the persistent and accessible nature of PIM. Furthermore, anxious-arousal mechanisms can explain the form of PIM through increased sensitivity to cardiovascular symptoms described earlier. From this view, RSM is linked to anxious-arousal, which results in ocular instability through the pulse-wave. What needs to be established is whether this type of anxiety-sensitivity is a common feature of traumatic memories.

1.8.4 Traumatic Memories and Anxiety Sensitivity

Anxiety symptoms appear to be particularly aversive for certain individuals and not for others. The most adequate theory to account for this vulnerability is the concept of anxiety sensitivity, which was developed by Reiss and McNally (1985) in order to explain the underlying dimensions in the fear of anxiety. According to McNally (1999), there are three second-order factors that underlie

general anxiety sensitivity. These include: fear of dangerous bodily sensations; fear of social evaluation of anxiety symptoms; and the fear of mental incapacitation. Anxiety sensitivity has been studied in the context of explaining the aetiology of a range of anxiety disorders, but most aptly applies to the predominant models of Panic Disorder (eg. Clark, 1986). Peterson and Reiss (1992) developed an Anxiety Sensitivity Index (ASI) that was subsequently tested on a number of anxiety conditions, and was found to predict the development of Panic Disorder. An unexpected finding was that individuals with PTSD had elevations in ASI scores beyond any other anxiety disorder apart from Panic Disorder. Parallels can be drawn between Panic Disorder and PTSD with respect to the underlying anxiety sensitivity characteristics. For example, in Panic Disorder, the misinterpretation of bodily sensations associated with anxiety (specifically heart-related symptoms) has been hypothesised to escalate into panic (Clark, 1988). In people with PTSD, misinterpretation of perceptual symptoms may escalate into DR (in the form of flashbacks). Indeed, the ASI has been shown to discriminate between PTSD and Panic Disorder in terms of the second-order factors (see Cox, Borger & Enns, 1999). With panic disorder, the misinterpretation tends to be bound with a fear of dangerous bodily sensations, and with PTSD it tends to be a fear of mental incapacitation (Cox, Borger & Enns, 1999). Other studies have found that the symptom of re-experiencing in PTSD tends to be associated with a fear of insanity (Halligan, Clark & Ehlers, 2002; Ehlers & Clark, 2000) as is DP/DR in other psychological disorders

(Hunter et al., 2003). Moreover, those with PTSD tend to report dissociative symptoms that have been linked to a fear of mental dyscontrol (Hunter et al., 2003). Individuals with such a fear may actually predispose themselves to experiencing visual-distortions through attentional bias and cognitive elaboration.

Several recent studies have also supported the association between AS as a dimensional construct with the development of traumatic pathology. For example, Bryant and Panasetis, (2001) found that high levels of self-reported AS were associated with the development of Acute Stress Disorder (ASD) in persons who had experienced either a motor-vehicle accident or nonsexual assault. In a separate study, Lang and colleagues (2002) found that women who had experienced intimate partner violence (IPV) with a history of chronic PTSD scored significantly higher on the ASI when compared to women who had experienced IPV with no history of PTSD. The most recent study to investigate the relationship between AS and PTSD conducted by Feldner and colleagues (2006) has found that persons with high AS interacted with high frequency of traumatic exposure to result in a higher severity of PTSD symptoms. Interestingly, the frequency of traumatic exposure had little or no effect on the development or severity of PTSD symptoms in persons low in AS, which suggests that low AS may be a protective factor. Issues relating to directionality is a major difficulty cited in the limited range of empirical studies conducted so

far. It is unclear whether high AS exacerbates PTSD symptoms (as suggested by Keogh et al., 2002) or whether the experience of traumatic life events increases AS (Feldner et al., 2006: Halligan, Clark & Ehlers, 2002; Ehlers & Clark, 2000). It is likely that a bi-directional relationship exists between AS and traumatic experiences (Feldner et al., 2006)

Anxiety sensitivity is linked to traumatic memories in PTSD and sensory disturbances (Halligan, Clark & Ehlers, 2002; Ehlers & Clark, 2000; Grunfeld, et al., 2000). Consequently, if AS shows similar links to RSM and PIM, then it would help explain why ocular movement from a pulsatile origin is noticed in some individuals and not others. It could be the case that those with high AS (specifically a fear of cognitive dyscontrol) are more likely to notice small ocular movements due to a fear of what these symptom indicate. The fear of visual anomalies may be established during the pairing of sensory disturbances with a traumatic experience.

1.9 Summary and Aims for Present Studies

Although visual disturbances have been shown to be important concomitants of anxiety conditions, little is known about their origin and role in anxiety pathology. PIM is one visual disturbance that has been associated with psychopathological conditions, including PTSD. There are several mechanisms that may be responsible for producing PIM; they include: nystagmoid eye-

movements (Tkalcevic & Abel, 2003; Grunfeld, et al., 2000), dissociation (Steinberg, 1995; Miller et al., 1993; Trueman, 1983), pulse-wave (Kowal, 1999; Sanchez, Sennes & Bento, 1999), or other physiological processes associated with physiological arousal (Van Diest et al., 2000; Van Der Molen, et al., 1988). Of these mechanisms, eye-movements (whether nystagmoid or other forms of ocular movement) are the most established cause of visual instability.

Dissociation is often linked to perceptual disturbances (Miller et al., 1993; Trueman, 1983). Although most visual disturbances accompanying anxiety states are conceptualised as dissociative phenomena, there are few mechanisms able to explain the cause of these disturbances. Derealization has often been used to describe a group of anomalous perceptual and subjective states without offering a clear explanation for the cause of these symptoms. As a result, it is difficult to determine if perceptual disturbances are caused by dissociative states, or if derealization results from perceptual disturbances. Nevertheless, derealization shares some common characteristics with PIM, including similar methods of induction (Miller et al., 1993) and a high prevalence in persons with PTSD (Speigel & Cardena, 1991). If PIM is highly related to dissociation, then it would suggest that this specific disturbance is a marker for underlying dissociative processes. However, the notion that dissociation causes PIM is not sufficiently supported by the literature and would be difficult to empirically test.

The other plausible cause of PIM may lie in physiological arousal mechanisms, which include respiratory symptoms (Van Diest et al., 2000) and cardiovascular symptoms (Hix, Reingold & Hammond, 2002). Of particular interest is the capacity of the pulse-wave to produce a rhythmic aural disturbance (Sanchez, Sennes & Bento, 1999). The observation that PIM is associated with a range of psychological disorders may be due to common anxiogenic vulnerabilities such as a fear of cognitive dyscontrol (Hunter et al., 2003), and sensitivity to cardiac changes (Pennebaker & Watson, 1991; Richards & Bertram, 2000). Furthermore, visual instability caused by arousal may be interpreted as an indicator of impending mental dyscontrol, as perceptual disturbances are often present during a panic attack (Cassano, et al., 1989) or a traumatic incident (Ehlers, Mayou, & Bryant, 1998; Murray, Ehlers & Mayou, 2002). This type of mechanism would not only explain the cause of PIM, but also its relationship to psychological conditions characterised by anxiety.

The primary aim of this research is to determine the mechanism responsible for the signal generation underlying PIM. Of the reviewed mechanisms, systemic movement caused by pulse-wave appears to be the best explanation for PIM due to its rhythmic nature, corresponding frequency range and tendency to be misinterpreted in persons with high levels of anxiety sensitivity. The secondary aim is to explain the observed concordance between RSM and PIM. The proposed explanation is that both PIM and RSM are dissociative-anxiety

symptoms, and as a result, tend to co-occur in conditions where these processes are apparent. The exact role of dissociation, anxious-arousal and anxiety sensitivity in both the generation of PIM and it concordance with RSM will be explored.

1.9.1 Structure of the Thesis

This thesis is separated into three studies addressing the research aims. The first study (Chapter 2) concerns the operational definitions of PIM and RSM phenomenon, and the establishment of standard methodological procedures to assess their presence. The primary aim is to address some of the limitations stated in the Tym et al. (2000) study, including an operational definition of RSM that reflects the criteria used in the clinical study. Additionally, Study 1 aims to adopt perceptual apparatus to minimise erroneous head movements and increase the reliability of the results obtained. If PIM exists once these methodological concerns are addressed, it can be concluded that PIM is not an artefact of these design flaws and obtained base-rates can be meaningfully compared with earlier research.

Study 2 (Chapter 3) is concerned with establishing reliability for the assessment procedures and instruments used in assessing PIM and RSM. Related to this, Study 2 will also provide useful information on the stability of PIM and RSM symptoms over a one-week time frame. Reliability estimates for PIM and RSM

will be established by assessing Intra-rater reliability and Inter-Rater reliability. As reliability testing has yet to be formally conducted on PIM and RSM measures, this study will significantly contribute to the understanding of the nature of these symptoms.

Study 3 (Chapters 4, 5 & 6) is focused on three major aspects regarding the relationship between RSM and PIM. Study 3 has four major aims: 1) to examine which sub-component of RSM best predicts PIM status; 2) to test the predictive relationship dissociative-anxiety variables and PIM and RSM status 3) to test whether a relationship between pulse-rate and PIM oscillation rate exists, and 4) to investigate the relationship between PIM, RSM and critical flicker/fusion thresholds. These aims will yield information on whether the base and concordance rates of PIM and RSM are comparable to the Tym et al. (2000) study, as well as establishing which feature of this memory symptom is most strongly related to PIM.

Study 3 will also provide information on the association between PIM/RSM with anxious-arousal, dissociation and anxiety sensitivity to determine which of these symptom clusters best accounts for the concordance between the two symptoms. As reviewed in this chapter, visual disturbances related to anxiety states have been linked to arousal mechanisms, dissociative states (e.g., DP/DR), and a tendency to fear anxious symptoms (i.e., anxiety sensitivity). Traumatic

memories inherent in post-traumatic stress syndromes have also been linked to these symptom groups and anxiogenic vulnerabilities. A major aim of Study 3 is to investigate whether PIM and RSM are linked through common underlying mechanisms and share similar anxiogenic vulnerabilities.

Another major aim of Study 3 is to test whether a relationship exists between Pulse-Rate and PIM oscillation rate. As discussed earlier, the ocular movement resulting from the pulse-wave best accounts for the properties of PIM as well as its specificity to a subset of anxious individuals. This will be achieved through experimental manipulation of the pulse-rate, and observation of the impact of this change on PIM oscillation rate. Study 3 will also examine the relationship between RSM/PIM and CFF to determine whether these symptoms are associated with cortical arousal and an increased visual sensitivity to flicker. This aim is based on links in the literature between levels of cortical arousal and visual instability (Coren, 2002). It is unknown whether the PIM form of visual instability is linked to high levels of cortical arousal. This study aims to explore whether a relationship exists between PIM, RSM and CFF. If both RSM and PIM are related to higher CFF, then it can be assumed that cortical arousal plays a role in PIM, and accounts for its relationship to RSM. A significant relationship between PIM and CFF will also aid in establishing flicker thresholds as a convergent index for this visual disturbance.

Chapter 2

Study One. Overcoming Problems of Method: Operationally Defining PIM and RSM

2.0 Introduction.

The purpose of this study is to establish a standard assessment protocol for PIM and RSM, and to collect observational data on the base-rates of these phenomena in a student sample. Prior to investigating the aetiology of PIM, several methodological issues highlighted in the Tym et al. (2000) study need to be addressed. The existence of PIM as a discrete perceptual phenomenon can only be verified once potential sources of error are controlled. Based on this, the current study aims to establish whether PIM persists after sources of erroneous movement are controlled. Possible limitations in research design and proposed methods to address these limitations will now be discussed.

2.0.1 Sample Characteristics

Tym et al. (2000) used a convenience sampling method to recruit participants for their studies. The use of convenience sampling has the potential to be problematic, however it is considered a suitable strategy for exploratory research or investigations into previously under-researched topics (Burns, 1997). A potential limitation of convenience sampling is the non-representativeness of the sample characteristics to the inferred population. In the case of the Tym et al. study, the community sample was drawn from two populations (university and

optometry practice). It is unlikely that these samples would adequately represent the target population (i.e., the community), especially with regards to the optometry sample in which abnormal vision is likely to be more prevalent. This recruiting strategy was likely to increase the rate of those experiencing visual disturbances in the total sample, thereby increasing error and reducing representativeness.

Another limitation of the research design was the absence of quota controls in the sampling strategy. In particular, gender was not equally represented in both clinical and community samples. As PTSD, PIM and RSM appear to be more common in females (American Psychiatric Association, 1994; Tym et al., 2000), an imbalanced gender representation would impact on the reported base and concordance rates and lead to an increase in sampling error (Burns, 1997). As gender approaches equal distribution in the target population (i.e., the community), the generalisability of the research findings beyond the accessible population is limited. The representation of gender will be a consideration in this study.

2.0.2 Inconsistent Definitions

Prior to assessing the presence of specific phenomena, the development of clear operational definitions is required (Graziano & Raulin, 2004). Inconsistencies between operational definitions within or between studies may lead to invalid

results. In the Tym et al. study, the operational definition for RSM differed between the community and clinical samples. In the community study, the operational definition of RSM was based on the diagnostic criteria for PTSD, whereas the clinical study used an exclusive definition (see section 1.7). Related to this is the use of unspecified assessment techniques (e.g., self report questionnaires and interviews) that varied across community and clinical studies. Such inconsistencies make data from the two studies difficult to compare. A recommendation of the Tym et al. (2000) study was to adopt a similar operational definition of RSM (i.e., the definition in the clinical study rather than the formal DSM-IV definition of re-experiencing) as well as a standard method of assessment (i.e., specific to the operational definition of RSM rather than the use of structured clinical interviews designed for clinically significant symptoms).

The PTSD specific criteria for RSM used in the community study may have lead to an underestimation of RSM base-rates rates, and potentially weakened the strength of the relationship between RSM and PIM. Tym et al. (2000) acknowledged this as a possible source of error, and recommended the use of the RSM criteria stipulated in the clinical study. Indeed, post-hoc investigation of the relationship between RSM and PIM after removing PTSD specific criteria led to a strengthening of the concordance rate (Tym et al., 2000). This provides a rationale for reinvestigating PIM and RSM in an unselected student sample using

the original definition of RSM, so that the base-rates and concordance rates can be meaningfully compared to the Tym et al. (2000) clinical study.

Tym et al. (2000) stated that the i-Test elicited a number of "normal" illusions in both clinical and community samples. The base-rates of these normal illusions and their relationship to RSM were not documented. This information is useful because PIM cannot be established as a unique visual marker of fearful memories without knowing the relationship between other forms of i-Test elicited illusions and RSM. It could be the case that another form of i-Test elicited illusion has a stronger concordance with RSM. If this were the case, then it would impact on the focus of this research by extending the proposed mechanisms to account for other forms of visual illusions. Further from this, the absence of data on other visual symptoms could result in an increase in Type 1 error. For example, visual symptoms with similar features to PIM (e.g., persistent movement) could result in the erroneous classification of some participants as PIM positive. Without data on other visual symptoms, it is difficult to know whether PIM is the only i-Test visual symptom associated with RSM. This study will aim to address this limitation by collecting data on the base rates of other i-Test elicited visual illusions.

2.0.3 Measurement Error

Two major sources of measurement error may have impacted on the reliability of Tym et al results. The first source of error relates to the absence of standard apparatus used widely in visual-perceptual experiments. More specifically, the use of stabilisation frames is standard in the assessment of many perceptual tasks, including the specific assessment of oscillopsia (see Tkalcevic & Abel, 2003). Furthermore, the i-Test stimulus was held by hand rather than in a fixed position, which may have led to erroneous movement of the target stimulus. These two sources of potential error may lead to an increase in false-positive PIM classifications. This is a potential problem where the experimenter is aware of the participant's RSM status, and may inadvertently classify erroneous movement as PIM based on expectation.

Another possible source of error relates to the measurement of the rate of PIM movement. Tym et al. (2000) stated that PIM took the form of rhythmical movement at the rate of 1 to 3Hz. However, there was no clear indication of how this rate was determined. Inaccurate measurement of PIM oscillation rate limits the use of this feature as an inclusion criterion. Furthermore, the relationship between the speed of oscillation and severity of other symptoms remains unknown. An accurate measurement of PIM oscillation rate will allow other variables to be experimentally manipulated and its effect on PIM

oscillation rate observed. It may also provide clues as to the aetiology of PIM, if the rate of movement corresponds with established causes of visual instability (e.g., nystagmus). This current study aims to introduce methods to enable the accurate measurement of the rate of PIM oscillations.

2.0.4 Demand Characteristics

Tym et al. (2000) stated that the assessment of PIM and RSM requires independent replication to ensure that the results were not tainted by unanticipated demand characteristics. One potential source of experimental error is the lack of subject naivety to the purpose of the research, leading to an increase in subject effects (Graziano & Raulin, 2004). In the assessment of subjective perceptual phenomena, the influence of the experimenter's expectations can be particularly powerful (Day, 1997; Ozeki, Takahashi & Tsuji, 1991; Wallace & Garrett, 1973). This is especially the case with the Autokinetic Phenomenon, where subject suggestibility and experimenter expectancies have a large influence on the form of the illusion (Royce et al., 1966). Research findings into the role of suggestibility in the Autokinetic Illusion are particularly important in the current study, as PIM could be a form of this illusion. Furthermore, it is well established that post traumatic stress syndromes are associated with increases in dissociative suggestibility (Merckelbach & Muris, 2001). This implies that persons with RSM may be more suggestible to experimenter expectancies, and therefore more likely to perceive illusionary

movement during visual fixation. Likewise, memory symptoms are equally susceptible to experimenter expectancies (Drivdahl & Zaragoza, 2001; Pickel, 1999; Blank, 1998) and subject suggestibility (Loftus 2001; Gudjonsson, 1987). Such an association between suggestibility, traumatic anxiety and the perception of illusionary movement could account for the high correlations between RSM and PIM observed in the Tym et al. (2000) study. These potential sources of error can be limited by use of automated assessment procedures and strictly limiting the participants' knowledge of the research aims (Graziana & Raulin, 2004), and assessing visual symptoms prior to RSM.

2.1 Methods to Address Limitations

The current study aims to reduce potential error by establishing a standard methodology for assessing PIM and RSM. This includes 1) the use of perceptual apparatus to reduce erroneous head movement and control viewing distance/angle, 2) the appropriate use of quota limits to increase representativeness and reduce sampling error; and 3) the use of questionnaires in order to limit demand characteristics and reduce other sources of experimenter bias. The use of these methodologies will be discussed in more detail in subsequent sections.

2.1.1 Perceptual Apparatus

The use of head stabilisation apparatus is widespread in visual-perceptual research (Dijkerman, Milner & Carey, 1999; Mamassian, Kersten & Knill, 1996; Bonnardel, Bellemore & Mollon, 1996; Ashida & Osaka, 1995). Most commonly, participants are required to use a chin rest to minimise head movements (de Brouwer, Yuksei. Blohm, Missal & Lefevre, 2002; Dijkerman et al., 1999). The use of a frame surrounding the face is also used in conjunction with a chin rest to reduce the degree of head movement when viewing a stimulus (Ashida & Osaka, 1995). This has the added benefit of standardising the amount of head movement between subjects, in addition to reducing the influence of erroneous head movement on the perceptual task.

The use of head stabilisation apparatus is particularly relevant for the current study, as head movements have been associated with visual instability in persons with vestibular deficits (Furman & Jacob, 2001; Tkalcevic & Abel, 2003). In individuals with vestibular dysfunction, methods to reduce head movements led to a corresponding reduction in oscillopsia (Tkalcevic & Abel, 2003). If PIM originates from a similar vestibular mechanism, then it would be likely that the observed base-rates would be significantly lower once head movements are reduced. Conversely, if PIM persists once head stabilisation methods are in place, then it can be assumed that another mechanism is responsible for causing the visual instability.

An added benefit to the use of head stabilisation frames is that the viewing length and angle can be controlled rather than approximated. Tym et al. (2000) estimated the viewing length and did not state whether the viewing angle was controlled. In this study, the use of head stabilisation apparatus will assist in the standard administration of the i-Test perceptual task.

2.1.2 Sampling and Quota Limits

As mentioned earlier, convenience sampling is suitable in situations where little is known about the research topic. PIM and RSM are clearly under-researched phenomena, and therefore the use of convenience sampling is justifiable. However this study will differ from the Tym et al. (2000) study in that the specified target population will be defined as unselected student sample instead of community. It is acknowledged that the sample in this study will not be representative of the entire community, and therefore inferences made cannot be generalised beyond a university-based population. However these limitations do not conflict with the aim to investigate the aetiology and correlates of PIM within an unselected student sample.

This study will also introduce quota limits for gender into the sampling strategy. Tym et al. (2000) documented a gender difference in both PIM and RSM, with females displaying these symptoms more often than males. In the Tym et al.

(2000) community study, 73.4% of participants were female compared to 52.1% in the clinical sample. If the relationship between gender and PIM/RSM is to be adequately investigated, an equal representation of males and females in the sample is required. This study will employ quota limits to ensure a balanced representation of gender.

2.1.3 Questionnaire Design

The use of self-administered questionnaires to assess RSM and PIM will reduce the potential effect of experimenter bias. Tym (personal communication, 2001) developed two questionnaires to assess the presence of PIM and RSM. These questionnaires were developed for the purpose of reducing the influence of experimenter bias and other sources of demand characteristics such as subject suggestibility. Another reason for the use of self-administered questionnaires is that each participant receives a standard set of identical questions. Furthermore, variations in the emphasis on certain words, voice inflections or the use of probes by the experimenter are eliminated by use of questionnaires. As mentioned earlier, the perception of illusionary movement in the Autokinetic Phenomenon is particularly susceptible to suggestion and expectation (Royce et al., 1966). Questionnaires were introduced to minimise the experimenter's influence on participants' responses.

2.2 Study One: Aims

The first study is concerned with collecting observational data on the base rate of RSM and PIM in a student sample using a newly developed questionnaire form of assessment. Based on the previous Tym et al. (2000) study, it is expected that there will be a significant concordance between PIM and RSM.

2.3 Method

2.3.1 Participants

A university-based sample (N = 142) was assessed to establish the base rates of PIM and RSM in a student sample. The age of participants ranged from 18 to 55 years (*M* = 23.3 years, *SD* = 7.4 years) and gender was equally represented (71 males and 71 females). Participants were recruited via university advertisements and announcements in lecture theatres at Curtin University of Technology, in Perth Western Australia. Academic staff, general staff, undergraduate and postgraduate students were asked to participate in order to gain a suitable representation of age. Demographic information was gathered from participants at the time of testing, and participants were asked whether they would like to participate in a follow-up experiment (see Appendix A). Two participants were excluded from the assessment based on pre-existing and non-corrected visual abnormalities or disease, and two participants' data were excluded because of incomplete questionnaires. All participants were naive to the aims of the research and participated on a voluntary basis.

2.3.2 Validating Sample Size for Chi-Square Analysis

The sample size for this experiment was determined by the Tym et al. (2000) community-based study, in which 128 participants were tested and significant effects were reported. In both clinical and community based studies, the base-rates for PIM ranged from 20% to 26%, which would be expected to yield between 26 to 33 participants with PIM. An average of this range would yield 29 individuals, which would require 145 participants to be sampled. An analysis of power indicated that at the alpha level of .05, and power set to 0.8, a medium effect size (Cohen's w = 0.3), 88 participants are required to adequately power the design (Cohen, 1988; Erdfelder, Faul & Buchner, 1996). For the current study, a target of 146 (73 men and 73 women) was set as the target, based on the anticipated base-rate of 20 to 26% of PIM positive cases in the sample. Due to non-included cases, the final sample consisted of 142 participants

2.3.3 Research Design

The study employed a correlational design using self-report measures of PIM and RSM.

2.3.4 Measures

2.3.4.1 Persistent Illusion of Visual Movement Questionnaire (PIVMQ)

The current study involved the administration of two separate measures that were yet to be formally tested at the time of this study. The PIVM questionnaire was developed by Tym (personal communication, 2001) as an accompaniment to the i-Test visual stimulus. The PIVMQ items were developed from the unspecified assessment methods used in the Tym et al. (2000) clinical study. The rationale for the development of the PIVMQ was to reduce the subjective assessment of PIM by automating the procedure and allowing self-administration of the questionnaire rather than relying on the clinical judgement of the experimenter. This measure was taken to reduce the possibility of unanticipated demand characteristics in the assessment of PIM. Furthermore, the development of a self-administered questionnaire allowed for the standard assessment of PIM between studies, so that results could be meaningfully compared.

The PIVMQ consists of 9 items that reflect the Tym et al. (2000) original criteria for assessing the presence of persistent visual movement. The items include a range of clinically non-significant visual anomalies (i.e., normal illusions) as well as PIM. Based on clinical observations, Tym used three descriptors of PIM (Flap, Wiggle or Pulsate) in the PIVMQ based on clinical observations from the previous studies (Tym et al., 2000).

Table 2
PIVMQ Items

Item 1	Did part of the image of the yellow strip seem to disappear briefly from time to time ?	Yes or No
Item 2	Did all the image of the yellow strip seem to disappear briefly from time to time ?	Yes or No
Item 3	Did it seem as though there were black 'shadows' on either side of the image?	Yes or No
Item 4	Did parts of the image of the yellow strip seem to change to a red colour ?	Yes or No
Item 5	Did parts of the image of the yellow strip fade to a grey colour?	Yes or No
Item 6	Did parts of the yellow strip move as though it was flapping side to side?	Yes or No
Sub Item 6.1	If yes (to Item 6), did it flap side to side all the time once it started?	Yes or No
Sub Item 6.2	If yes (to Item 6), did it flap side to side all the time once it started, except when you blinked?	Yes or No
Sub Item 6.3	If yes (to Item 6), did it flap side to side only very, very briefly. Once or twice or so.	Yes or No
Item 7	Did parts of the image of the yellow strip seem to move as though it was wiggling?	Yes or No
Sub Item 7.1	If yes (to Item 7), did it wiggle all the time once it started?	Yes or No
Sub Item 7.2	If yes (to Item 7), did it wiggle all the time once it started, except when you blinked?	Yes or No
Sub Item 7.3	If yes ((to Item 7), did it wiggle only very, very briefly. Once or twice or so.	Yes or No
Item 8	Did parts of the image of the yellow strip seem to move as though it was pulsating?	Yes or No
Item 8.1	If yes (to Item 8), did it pulsate all the time once it started?	Yes or No
Item 8.2	If yes (to Item 8), did it pulsate all the time once it started, except when you blinked?	Yes or No
Item 8.3	If yes (to Item 8), did it pulsate only very, very briefly. Once or twice or so.	Yes or No
Item 9	How many times a second did it seem to flap, wiggle or pulsate?	Less than once; once; twice; three; four; five; five to ten; more than ten

In Table 2, items 1 to 5 introduce non-PIM or "normal" illusions documented by Tym et al. (2000). Data on non-PIM symptoms were not collected in previous investigations. The introduction of items 1 to 5 will yield base rates of non-PIM illusions so that the specificity of PIM to RSM can be adequately assessed. Item 6.1, 7.1 and 8.1 are included to distinguish momentary from persistent forms of illusionary movement. There are six combinations of two sequential responses required for a PIM positive diagnosis; they are listed in the table below.

Table 3

PIVMQ Items Required for a PIM Positive Diagnosis

Item		Sub-item
Q6. Did parts of the yellow strip move as though it was flapping side to side? (Yes)	AND	Q6.1 Did it flap from side to side all the time once it started? (Yes) OR Q6.2 Did it flap from side to side once it started, except when you blinked? (Yes)
Q7. Did parts of the image of the yellow strip seem to move as though it was wiggling? (Yes)	AND	Q7.1 Did it seem to wiggle all the time once it started? (Yes) OR Q7.2 Did is seem to wiggle all the time, except when you blinked? (Yes)
Q8. Did parts of the image of the yellow strip seem to move as though it was pulsating? (Yes)	AND	Q8.1 Did it seem to pulsate all the time, once it started? (Yes) OR Q8.2 Did it seem to pulsate all the time, except when you blinked? (Yes)

Other visual anomalies, if reported in the absence of PIM specific items, are considered to be PIM negative. These normal illusions include the momentary disappearance of the target figure, appearance of black shadows surrounding the figure, and momentary colour change. Rhythmicity and oscillation rate were assessed by a single item: Q9 "How many times a second did it seem to flap, wiggle or pulsate?". Although this is not a precise gauge of oscillation rate, it will provide a participant derived estimation of the PIM oscillation rate without direct influence from the experimenter.

2.3.4.2 Abnormal Visual Memory Recall Questionnaire (AVMRQ)

The second questionnaire was used to assess the presence of recurring specific memories of a traumatic event (RSM). The AVMRQ consists of 14 items that reflect the criteria used to assess the presence of RSM in the Tym et al. (2000) clinical sample. This questionnaire was designed by Tym (personal communication, 2000) to detect intrusive memories of events without placing an emphasis on the intensity of the original trauma(s), which was cited as a limitation in the previous community-based study (Tym, et al., 2000). At the time of testing, the AVMRQ was the only instrument available to assess the criteria for RSM. As the AVMR questionnaire is essentially a collection of characteristics that reflect the phenomenology of RSM, it is deemed to be the most appropriate instrument for this study. As with the PIVM questionnaire, the

AVMRQ is designed to categorise participants as either RSM positive or negative.

The written instructions provided to participants prior to administration of the AVMRQ items were as follows.

> *We would like you to recall the memory of the most sudden, nasty, frightening situation that you have been in at any time in the past – perhaps many years in the past. This frightening situation could have been a major event in your life or something quite small, but a situation that frightened you nonetheless. Perhaps no one else knows about it and perhaps it wouldn't have frightened anyone else – but it frightened you.*
>
> *We don't want to know <u>what</u> happened, or <u>what</u> the frightening situation was. We just want you to concentrate on thinking about that frightening situation for a few moments. This might feel very unpleasant, and we are sorry if it does, but please try to hold the memory in your mind while you answer the following questions.*

Participants were offered contact details for university-based counselling services in case of any distress caused by the voluntary recall of unpleasant memories.

The participant instructions were followed by items listed in the following table.

Table 4

AVMRQ Items

Item Number	Question	Responses
Item 1	When you recall the frightening situation, do you remember? (you may tick more than one box)	a) Visual aspects of the situation b) Sounds of the situation c) Smells that were present in the situation d) Touch or other bodily sensations
Item 2	Which part of the memory seems the strongest? (tick one box only)	a) Visual b) Sounds c) Smells d) Touch or Other
Item 3	As you recall the frightening situation now, do you get a picture in your mind's eye of some part of it that you were seeing or looking at, at the time of the frightening situation?	a) Yes b) No
Item 4	As you recall the frightening situation now, do you begin to get any bodily feelings of fear?	a) Yes b) No
Item 4.1	If yes, do you…	a) Begin to get sweaty palms b) Begin to get unpleasant feelings in the stomach c) Begin to feel pains in your chest d) Begin to catch your breath

		e) Begin to get a bit of a tight headache
		f) Begin to get a bit of a thumping heart
Item 5	When you recall the frightening situation now, do you begin to feel unpleasant emotions?	a) Yes b) No
Item 5.1	If yes, do you…	a) Begin to feel angry
		b) Begin to feel ashamed
		c) Begin to feel sorrowful
		d) Begin to feel as though you want revenge
		e) Begin to feel a bit frightened and anxious
		f) Begin to feel depressed
		g) Begin to feel very frightened and anxious
Item 6	When you recall the frightening situation now, does it seem as though it's all still happening now, even though the frightening situation happened a long time ago ?	a) Yes c) No
Item 7	When you recall the frightening situation now do you get a very detailed picture in your mind's eye of some one thing that you were seeing or looking at, at the time of the frightening situation?	a) Yes b) No
Item 8	When you recall the frightening situation now, does it seem as though the frightening situation happened just recently, even though it happened a long time ago?	a) Yes b) No
Item 9	When you recall the frightening situation now, does it feel as though the frightening situation happened recently, even though it happened a long time ago?	a) Yes b) No
Item 10	Did the memory of the frightening situation rush back to you one day for the first time, and all of a sudden, after years and years of never being able to remember the frightening situation at all?	a) Yes b) No
Item 11	Have you always been able to recall the memory of the frightening situation at any time, ever since the	a) Yes

	time it happened?	b) No
Item 11.1	If yes, was it always frightening to remember?	a) Yes b) No
Item 12	Do you ever suddenly become wide awake in the middle of the night when it is dark, with a detailed picture in your mind's eye of some one thing that you were seeing or looking at, at the time of the frightening situation?	a) Yes b) No
Item 12.1	If yes, do you…	a) See the picture clearly, even though it is dark b) Feel frightened when you wake up c) Find it difficult to get back to sleep
Item 13	Do you ever suddenly get in your mind's eye, during the day when you are wide awake, a detailed picture of some one thing that you were seeing or looking at, at the time of the frightening situation?	a) Yes b) No
Item 13.1	If yes, does it make you instantly frightened?	a) Yes b) No
Item 14	Do certain things that occasionally happen or certain situations you occasionally get into from time to time, suddenly trigger-off a detailed picture of some one thing that you were seeing or looking at, at the time of the frightening situation?	a) Yes b) No
Item 14.1	If yes, does it make you instantly frightened?	a) Yes b) No

The items in the AVMRQ described in the above table, were based on the original criteria for RSM (see section 1.8). Items 1 to 3 were introduced as supplementary items to gauge the sensory modality of RSM. Previous investigations did not differentiate RSM on the basis of sensory modality, and as result, little is known on whether visual forms of RSM differ from other sensory

forms in its relationship to PIM. Items 4, 4.1, 5 and 5.1 were included to ascertain the presence of somatic and subjective fear responses accompanying recall of RSM (criterion e). Items 6 to 9 pertained to the vivid and temporally distorted aspects of RSM (criterion d). Items 10 and 11 were based on the availability criterion (criterion a), and enabled repressed or recovered memories to be excluded. Items 12 to 14.1 were included to account for the spontaneous, cued or voluntary recall of the fearful memory (criterion b). Items assessing criterion b were included so that different forms of memory recall could be investigated in relation to PIM status. The following patterns of responses were required for an RSM positive diagnosis.

Table 5

AVMR Responses Required For RSM Diagnosis

Item	Response	Criteria
Q3 As you recall the frightening situation now, do you begin to get any bodily feelings of fear?	Yes	Somatic Anxiety
Q4 When you recall the frightening situation now, do you begin to feel unpleasant emotions?	Yes	Subjective Anxiety
Q5 When you recall the frightening situation now, does it seem as though it's all still happening now, even though the frightening situation happened a long time ago?	Yes	Recency/Temporal Distortion
OR		
Q7 When you recall the frightening situation now, does it seem as though the frightening situation happened just recently, even though it happened a long time ago?		
Q2 As you recall the frightening situation now, do you get a picture in your mind's eye of some part of it that you were seeing or looking at, at the time of the frightening situation?	Yes	Clarity
OR		
Q6 When you recall the frightening situation now do you get very detailed picture in your mind's eye of some one thing that yc were seeing or looking at, at the time of the frightening situation?		
OR		
Q12 Do you ever suddenly get in your mind's eye, during the day when you are wide awake, a detailed picture of some one thing that you were seeing or looking at, at the time of the frightening situation?		
Q9 Did the memory of the frightening situation rush back to you one day for the first time, and all of a sudden, after years and years of never being able to remember the frightening situation at all?	No	Exclusion of previously repressed or recovered memories
Q10 Have you always been able to recall the memory of the frightening situation at any time, ever since the time it happened?	Yes	Availability

2.3.5 Apparatus

The apparatus used included the i-Test stimulus (Appendix B) and 10 custom-built viewing frames (see Appendix C). The i-Test was produced on a 21 cm x 30 cm matt black card with a yellow strip 1 cm x 5 cm placed centrally, which were the dimensions specified by Tym et al.(2000). A central target point was placed 1cm from the top of the yellow strip. The viewing frames were constructed in order to stabilise the i-Test visual stimulus, standardise the viewing distance, and reduce head movements. The viewing distance was 60cm to the i-Test stimulus, and the i-Test was adjustable to maintain constant visual angle perpendicular to the line of sight. The viewing distance was determined by the specifications stipulated in Tym et al. (2000) studies. A stopwatch was used to standardise exposure time to the i-Test stimulus.

2.3.6 Procedure

Participants were tested in small groups, ranging from 4 to 10 participants in each group. The viewing frames were placed around a laboratory bench with height-adjustable chairs. A demonstration of the correct position and use of the viewing frames was given prior to reading out the task instructions (see Appendix D). Once participants indicated that they understood the requirements of the procedure, information and consent forms were given to each participant to read and sign (see Appendix E). The participants were given approximately 10 seconds to comfortably position themselves prior to commencement of the 45

second testing period. Subjects were required to cover one eye with the palm of their hand while viewing the i-Test stimulus with the other eye. This method was a replication of the procedure stipulated in the Tym et al (2000) studies. The experimenter vocally indicated the commencement and termination of the 45-second period after which time the PIVM questionnaire was administered. Once the questions for the tested eye were completed, the procedure was repeated with the other eye after a short (approximately 1-minute) rest period. The participants were instructed to complete the AMVR questionnaire once the PIVM questionnaire was completed. The testing procedure took approximately 25 minutes to complete.

2.4 Results

The aims of this study were: a) to document the base-rates rate of PIM, non-PIM illusions and RSM in a student sample; b) to document the concordance rate between PIM and RSM; c) to investigate the concordance between non-PIM illusions and RSM. A Chi-Square analysis was selected due to the dichotomous nature of the variables concerned.

2.4.1 Assumption Testing for Chi-Square Analysis

Pearson's Chi-Square analysis has 3 underlying assumptions. The first assumption is that observations are randomly sampled from the population (Coakes & Steed, 1995). Although the sampling from this population was not

random, the use of quota controls to equally represent gender and the recruitment of participants from a range of disciplines adequately constitute a representative sample of a university population. The second and third assumptions are that each observation is generated independently and the expected frequency in each cell is greater than 5 (Coakes & Steed, 1995). Both these assumptions where met. In cases where the expected or observed cell frequency was 5 or less, Yates' correction for continuity was applied.

2.4.2 Frequency and Concordance Rates

Of the total sample, 77 (54.2%) were PIM positive, and 53 (37.3%) were RSM positive. The concordance rate between RSM and PIM was not statistically significant ($\underline{x}^2(1, N=142)$ 3.356, $p > 0.05$). The strength of the association between RSM and PIM was non significant with a Phi Statistic of .154 ($p > .05$). The base rates of non-PIM illusions included the total target disappearing (25.4%); part of the target disappearing (76.1%); illusionary shadows surrounding the target (83.8%); the target changing colour from yellow to red (7.7%); and the yellow target fading to grey (45.1%). There were no significant relationships between other visual illusions and RSM. Likewise, individual sub-components of PIM (flapping, wiggling & pulsating) did not significantly correlate with RSM. The proportions of participants in the PIM and RSM categories are displayed in Table 6.

Table 6

PIM/RSM Crosstabulation

			RSM		
			Negative	Positive	Total
PIM	Negative	Count	46	19	65
		Expected Count	40.7	24.3	65.0
		% within PIM	70.8%	29.2%	100.0%
		% within RSM	51.7%	35.8%	45.8%
		% of Total	32.4%	13.4%	45.8%
	Positive	Count	43	34	77
		Expected Count	48.3	28.7	77.0
		% within PIM	55.8%	44.2%	100.0%
		% within RSM	48.3%	64.2%	54.2%
		% of Total	30.3%	23.9%	54.2%
Total		Count	89	53	142
		Expected Count	89.0	53.0	142.0
		% within PIM	62.7%	37.3%	100.0%
		% within RSM	100.0%	100.0%	100.0%
		% of Total	62.7%	37.3%	100.0%

As indicated in the Table 6, 70.8% of participants who did not report PIM also did not report RSM. The remaining 29.2% of PIM negative participants were classified as RSM positive. Of the participants who were classified as PIM positive, 44.2% were also classified as RSM positive. The remaining 55.8% of participants who did not report RSM were classified as PIM positive.

Table 7

PIM and Gender Cross-Tabulation

			Gender		
			Male	Female	Total
PIM	Negative	Count	38	27	65
		Expected Count	32.5	32.5	65.0
		% within PIM	58.5%	41.5%	100.0%
		% within Gender	53.5%	38.5%	77.0%
		% of Total	26.8%	19.0%	45.8%
	Positive	Count	33	44	77
		Expected Count	38.5	38.5	77.0
		% within PIM	42.9%	57.1%	100.0%
		% within Gender	46.5%	62.0%	54.2%
		% of Total	23.2%	31.0%	54.2%
Total		Count	71	71	142
		Expected Count	71.0	71.0	142.0
		% within PIM	50.0%	50.0%	100.0%
		% within Gender	100.0%	100.0%	100.0%
		% of Total	50.0%	50.0%	100.0%

PIM appeared significantly related to gender [x^2(N=142) = 3.433, $p < 0.05$], with disproportionately more females (57%) reporting the illusion than males (42%). The Phi Statistic for the strength of association between PIM and gender indicated a non-significant effect of .155 ($p > .05$)

A gender difference was also observed in RSM [x^2 (N=142) = 3.643, $p < 0.05$] as displayed in the cross-tabulation below. Table 8 indicates that females are more

likely (60%) to report a RSM than males (40%). The Phi Statistic indicated a non significant association between RSM and Gender in this sample (Phi Statistic = .16, $p > .05$).

Table 8

RSM and Gender Cross-Tabulation

			Gender		
			Male	Female	Total
RSM	Negative	Count	50	39	89
		Expected Count	44.5	44.5	89.0
		% within RSM	56.2%	43.8%	100.0%
		% within Gender	70.4%	54.9%	62.7%
		% of Total	35.2%	27.5%	62.7%
	Positive	Count	21	32	53
		Expected Count	26.5	26.5	53.0
		% within RSM	39.6%	60.4%	100.0%
		% within Gender	29.6%	45.1%	37.3%
		% of Total	14.8%	22.5%	37.3%
Total		Count	71	71	142
		Expected Count	71.0	71.0	142.0
		% within PIM	50.0%	50.0%	100.0%
		% within Gender	100.0%	100.0%	100.0%
		% of Total	50.0%	50.0%	100.0%

There was no significant difference between the base-rates of PIM in right versus left eye (40.4% & 39.0% respectively), and unilateral PIM did not significantly relate to handedness [$x^2(N=142) = 1.685$, $p > 0.05$]. No order effects relating to which eye was tested first were evident [$x^2(N=142) = .085$, $p > 0.05$].

2.5 Discussion

The results of this study did not support a significant relationship between PIM and RSM. The proportion of participants reporting PIM was approaching chance probabilities, and the base-rates of RSM in the sample was significantly higher than previous studies (54% and 37% for PIM and RSM compared with approximately 20% for both symptoms in Tym et al, 2000). This may be due to invalid assessment instruments or the use of stabilisation apparatus to control for head movements. These points will be discussed further.

The data yielded from PIVMQ and AVMRQ appear to contain a substantial amount of error variance, and did not support a significant concordance between RSM and PIM. The base-rate of PIM in this sample is substantially higher than previously recorded rates in the Tym et al. (2000) clinical and community studies. There are two plausible explanations for this occurrence. The first explanation is that the questionnaires are not valid assessments of the phenomena described by Tym et al. (2000). It is possible that visual disturbances of similar form to PIM are being incorrectly categorised as PIM positive or PIM negative. This explanation relates directly to the validity of the PIVMQ instrument, as normal illusions may not be adequately assessed. Indeed Graziano and Raulin (2004) suggest that significant differences in obtained base-rates are sufficient evidence to challenge the validity of the instrumentation. It is important to note

that the Tym et al. (2000) clinical study utilised an interview method of assessment rather than questionnaires. The subsequent development of the PIVMQ and AMVRQ were an attempt to reduce experimenter error from the use of unstructured (and therefore difficult to replicate) assessment techniques.

The second explanation is that the use of stabilisation methods has lead to an increase in the occurrence of PIM. This would imply that PIM is a common visual disturbance that can be induced in the majority of the population under specific conditions (i.e., to lower threshold, reduce noise or increase signal strength). If this is the case, then alterations in the form of the assessment for PIM and RSM alone would not be expected to significantly change the observed base-rates. Reinvestigating PIM and RSM using different assessment procedures whilst maintaining the use of stabilisation apparatus will allow the source of error to be determined.

Although the use of stabilisation apparatus can explain the high base-rate of PIM, it does not explain why RSM is over-represented in the sample. This suggests that instrumentation problems lead to an increase in experimental error. There are several limitations of the PIVMQ and AVMRQ that may have lead to erroneous results. The first relates to poor content validity of both questionnaires. The items comprising the PIVMQ did not adequately represented visual illusions other than PIM. If another illusionary phenomena

with shared characteristics to PIM are not included in the questionnaire, then it would likely lead to an increase in false positive classification. For example, rhythmical and persistent movement of illusionary shadows around the target figure and persistent fading and reappearing of the target figure are two non-PIM responses that have been previously documented from informal experimentation with the i-Test stimulus (Tym, Personal Communication, 2001). Both shadow movement and fading responses share similar characteristics with PIM (i.e., rhythmical and persistent illusionary changes to the target figure), and therefore could lead to an increase in false-positive responses if they are not adequately distinguished from PIM.

The other limitation is that of loading effects. As visual-perceptual phenomena are particularly susceptible to suggestion (Day, 1997; Ozeki, Takahashi & Tsuji, 1991; Wallace & Garrett, 1973), the items themselves may have produced such an effect. Loading effects such as these might have resulted in an increase in explicit demand characteristics through an attempt to reduce implicit demand characteristics.

The higher than expected base-rates for RSM could be due to item interpretability in the AVMRQ. Some authors have suggested that excessively long items can be detrimental to the validity of the responses (Graziano & Raulin, 2004). This limitation is clearly evident in the AVMRQ. For example,

Question 12 on the AVMRQ reads "Do you ever suddenly become wide awake in the middle of the night when it is dark, with a detailed picture in your mind's eye of some one thing that you were seeing or looking at, at the time of the frightening situation?". This item is also double-barrelled (i.e., introduces two or more ideas in the same question), and has poor face validity (i.e., does not clearly reflect any of the stipulated criteria for RSM), which in combination would cast doubt on the validity of this item and the instrument as a whole.

Although the validity of the PIVMQ and AVMRQ are questionable, these data suggest that visual illusions elicited by the i-Test perceptual task are commonly reported through this method of assessment. The results also suggest that changes in the methods of PIM and RSM assessment can produce dramatically different base rates. The reported base rates in Tym et al. (2000) of approximately 20% for both RSM and PIM were derived from unspecified assessment techniques (i.e., PIVMQ and AVMRQ were not used in these studies). This supports the rationale for developing new assessment procedures based closely on the methods and criteria used in the Tym et al. (2000) clinical study to enable a meaningful comparison of results. These new assessment procedures will be described and tested in Study 2.

Chapter 3

Study Two: Reliability Analysis of PIM and RSM Measures

3.0 Introduction

Previous studies by Tym et al. (2000) had documented the characteristics of PIM and RSM, however the reliability of these phenomena is yet to be adequately assessed. Part of the difficulty in assessing the reliability of PIM and RSM phenomena is due to the lack of standardised methods for assessing the presence of these symptoms. Tym (Personal Communication, 2001) created two questionnaires to assess PIM and RSM (the PIVMQ and AMVRQ respectively) based on the criteria stipulated in the Tym et al. (2000) clinical study. It is important to note that the Tym et al. (2000) original clinical study assessed PIM and RSM via an interview rather than these structured questionnaires. The rationale for the development of self-administered questionnaires was related to unspecified interview techniques in the original Tym et al. (2000) clinical study. It was suggested that a lack of a standard method of assessment for PIM and RSM could have resulted in an unacceptable level of experimenter bias confounding the assessment of these symptoms and leading to erroneous results. The PIVMQ and AMVRQ addressed this possible limitation by assessing the stipulated criteria via self-administered questionnaires. The Tym et al. (2000) community based study utilised questionnaires to assess the presence of these symptoms, however, due to differences in how these phenomena were

operationally defined the data could not be meaningfully compared with the original clinical based study.

The AMVRQ and PIVMQ were used in Study 1, and the data obtained did not support a significant relationship between RSM and PIM. A possible explanation for the lack of an observed relationship is that the use of questionnaires may have confounded the assessment of PIM. As discussed in Chapter 2, the content validity of AMVRQ and PIVMQ is questionable given the inclusion of items that did not clearly reflect any of the criteria stipulated for PIM or RSM. Furthermore, the development of forced choice items in order to classify PIM and non-PIM visual symptoms is premature given that no data on the form or frequency of non-PIM illusions exists. Given this, it is plausible that the observed proportions of the sample with RSM and PIM, and the lack of a relationship between the two phenomena, is due to unreliable and invalid assessment of these symptoms.

A thorough analysis of validity is difficult to conduct at this stage due to the anomalous nature of the PIM (i.e., not enough is known about the basic properties of PIM to conduct convergent validity assessments on any other form of illusionary movement). As there are no widely established measures for assessing PIM other than those described by Tym et al. (2000), an analysis of convergent validity is not possible. Content validity can be established by

clearly reflecting the stipulated criteria for RSM and PIM in constructed assessment instruments. As the validity of the AMVRQ and PIMQ is questionable (see section 2.5), an assessment of reliability of these measures would be of limited value. Given these limitations of the AVMRQ and PIMQ, it is proposed that new semi-structured interviews based closely on the original criteria stipulated in Tym et al. (2000) are developed to assess PIM and RSM. An interview method of assessment will more closely replicate the original assessment process used in the Tym et al. clinical study (2000), and would likely yield more comparable results.

The purpose of this study is to test the reliability of newly developed semi-structured interviews in assessing PIM and RSM symptoms. An assessment of reliability for these measures will be achieved through an analysis of inter-rater and intra-rater reliability. It is expected that inter-rater reliability will give an indication of the reliability of the interviews in assessing the presence of PIM and RSM and intra-rater reliability analysis will also yield additional information on the stability of both PIM and RSM symptoms over time. The 30 minute test-retest time interval was determined by the approximate length of time between two administrations of the i-Test in Study 3 (see section 5.4). This will enable the effect of exercise on the PIM illusion to be meaningfully interpreted in the subsequent study. A one-week time interval will give an indication of the stability of RSM and PIM symptoms over a longer time period where any

transitory or state depended effects are less likely to have the same degree of influence.

Two raters (R1, R2) tested 50 participants for PIM and RSM across three testing sessions (T1, T2, T3). The interval between testing sessions was 30 minutes between T1 and T2 and one week between T2 and T3. Two aspects of reliability were measured: *Intra*-rater reliability, which provides an index of the temporal stability of each rater's PIM and RSM assessments (and an estimate of the stability of these symptoms); and *inter*-rater reliability, which provides an index of the degree of correspondence between R1 & R2 with respect to their PIM and RSM assessments.

The intraclass correlation coefficient (ICC) was used to measure both types of reliability. The ICC can be computed according to three models. These have been labelled Model 1, Model 2, and Model 3 (for a detailed discussion of the three models see Portney & Watkins, 2000). Model 3 does *not* permit generalisations to other raters. This model is therefore appropriate for assessing intra-rater reliability where the focus is on the temporal stability of a *particular* rater's assessment. Model 2 does permit generalisations to other raters, and is therefore appropriate for assessing inter-rater reliability where the focus is on generalising to other raters.

SPSS's SCALE: RELIABILITY ANALYSIS procedure was used to compute the ICCs. All ICCs were derived from dichotomous data indicating the presence or

absence of PIM/RSM. With data that are rated as a dichotomy, the inter-rater ICC has been shown to be equivalent to measures of nominal agreement such as Kappa (Fleiss & Cohen, 1973). The ICC rather than Kappa was chosen as the statistical measure of reliability because: (i) SPSS provides confidence intervals for the ICC, and (ii) SPSS can more readily compute the intra-rater ICC than the corresponding Kappa when there are more than two assessments.

3.1 Method

3.1.1 Sample Size Required for Determining Reliability of the PIM-SSI and the RSM-SSI.

The number of participants required to adequately assess both inter-rater reliability and intra-rater reliability of the PIM-SSI (described in detail in section 3.1.3.3) and the RSM-SSI (described in detail in section 3.1.3.4) were based on the observed confidence intervals using a sample of 50 participants (see confidence intervals in Tables x to x). The relatively narrow confidence intervals suggests that a sample of 50 participants is adequate to estimate inter and intra rater reliability.

3.1.2 Participants

The sample consisted of 50 participants, with a mean age of 21.52 years (SD = 5.13 years). There were 25 males and 25 females in the sample. The participants for this study were recruited through announcements at lecture theatres. All participants were unaware of the aims and hypotheses of the study, and only informed that it was an exploratory study into visual and memory symptoms (see information sheet, Appendix F).

3.1.3 Materials & Apparatus

3.1.3.1 i-Test Stimulus

This study used the same i-Test stimulus and viewing frame as were used in Study 1 (see section 1.1 for a description of the stimulus) along with a stopwatch to measure onset times for PIM.

3.1.3.2 Auditory Metronome

A computerised metronome was used in this study to gauge the oscillation rate of PIM movement in cycles per second, by allowing participants to match the frequency of tones to the speed of illusionary movement. This provides a more accurate measurement of PIM oscillation rate compared to the post-hoc estimation in previous investigations. The metronome was developed using an

object-oriented version of the C programming language (C++), and utilized the Microsoft Foundation Class Graphical User Interface Libraries (MFC-GUIL). The MFC-GUIL dialog-based application framework was used to generate a single monophonic tone at intervals ranging from 0.2Hz to 4.0Hz in 0.2Hz increments. The default frequency was 1.0Hz and could be adjusted via buttons on a user-controlled input device. The computerised metronome displayed the frequency on a LCD computer screen. The software application was run on a Toshiba (model T1950CS) notebook-computer.

The computerised metronome was validated through waveform analysis of the audio signals produced. Sound Studio version 2.1 for the Apple Macintosh platform was used to record the audio signals produced by the metronome (Kwok, 2003). Visual inspection of the wavelength indicates that the auditory metronome used in this study accurately represents the 0.2Hz to 4.0Hz tone range (see Appendix G).

3.1.3.3 Persistent Illusion of Movement Semi-Structured Interview (PIM-SSI)

The Persistent Illusion of Movement Semi-Structured Interview (PIM-SSI) (Appendix H) was developed in order to address the potential threats to validity apparent in the PIVMQ. The items on the PIM-SSI were developed directly from the PIM criteria stipulated by Tym et al., (2000). The rationale for the development of the PIM-SSI was to allow participants to describe their

perceptual symptoms rather than select from predetermined options. This also allows for an entire range of i-Test elicited illusions to be documented, and the relationship between RSM and these illusions to be adequately assessed.

An emphasis was placed on the two central features of PIM, which included rhythmicity and persistence. The PIM-SSI consisted of 5 items, and differed from the PIVMQ in that the item pertaining to the perceptual disturbance is an open rather than closed question. This ameliorates the potential loading effects by removing the description of specific visual disturbances in the assessment of PIM. In addition to this, the PIM-SSI includes the recording of subjective descriptions of perceptual disturbances during the 45-second test period. This enables data to be collected on a range of perceptual experiences beyond the prescribed set included in the PIVMQ.

Table 9

Item Classification in the PIM-SSI

Question	**Response**	**Classification/Outcome**
Question 1 Describe in your own words what you saw when looking at the stimulus.	Non-Movement Response	Go to Question 2
	Movement Response	Go to Question 3
Question 2 Did it fade and reappear rhythmically?	Yes or No	PIM Negative
Question 3 How would you describe the movement?	Flapping, pulsating, vibrating, drift or other non-specific movement response.	Go to Question 4
Question 4 In what direction did it move or drift?	Unidirectional	PIM Negative
	Bidirectional or Mulitdirectional	Go to Question 5
Question 5 Was the movement rhythmical?	No	PIM Negative
	Yes	Go to Question 5
Question 6 Once you saw the movement, did it persist for the remainder of the viewing time?	No	PIM Negative
	Yes	PIM Positive

The items that comprise the PIM-SSI reflect the original criteria for PIM stipulated in Tym et al. (2000). Namely, items 3, 4 and 5 assess the presence of bi/multidirectional rhythmical and persistent qualities of PIM respectively. It is important to note that specific descriptors (e.g., flapping, wiggling, vibrating) were not essential for a PIM positive diagnosis as there is little evidence that these descriptions of movement are significantly different from other movement-based responses. Item 2 "Did it fade a reappear rhythmically" was added to distinguish a non-movement based rhythmical and persistent visual illusion that could confound the accurate detection of PIM. Fading and reappearing of the i-Test target figure had been reported in earlier experimentation with the i-Test, and was included in the PIM-SSI to differentiate this response from the PIM (Tym, Personal Communication, 2001). A scoring key (Appendix H) was used to code responses for the PIM-SSI.

3.1.3.4 Recurrent Specific Memory Semi Structured Interview (RSM-SSI)

The Recurrent Specific Memory Semi Structured Interview (RSM-SSI) (see Appendix I) was developed as an alternative to the AVMRQ in order to address some limitations evident in the first study. The interview is based on the original criteria specified by Tym et al. (2000) (see section 1.8), and consists of 8 items. Unlike the AVMRQ, the RSM-SSI does not place emphasis on the nature of the traumatic event and does not include PTSD specific criteria. Each of the 8 items is comprised of several questions based on the underlying criteria. The open

format of the questions allows the participant to elaborate on the features of the memory. The RSM-SSI items focus on: 1) clarity; 2) sensory modality; 3) somatic reactions; 4) emotional reactions; and 5) emotional experiences at the time of the event based on the original criteria from Tym et al. Prompts were used in cases where participant responses were vague or ambiguous (see Appendix I for the RSM-SSI including prompt statements/questions).

Table 10
Item Classification in the RSM-SSI

Question	Response	Classification/Outcome
Question 1 Do you have a fearful memory and if so, is this the only memory that makes you feel uncomfortable?	No fearful memories	RSM Negative
	One specific fearful memory.	Go to Question 2
	More than one specific fearful memory.	
Question 2 How clear and vivid is your memory of the frightening experience	Unclear.	RSM Negative
	Clear.	Go to Question 3
Question 3 Is your memory as clear and vivid as it was immediately after you had the frightening experience.	No, less vivid now.	RSM Negative
	Yes, just as clear.	Go to Question 4
Question 4 When you are remembering the frightening experience, do you experience any emotions in the present? Are they the same emotions you experienced when the events were actually happening	No, different emotions or no emotional reactions.	RSM Negative
	Yes, fear and anxiety	Go to Question 5
Question 5 Can you think of a period of time that you were unable to remember this frightening experience?	Yes	RSM Negative
	No	Go to Question 6
Question 6 What senses are "activated" when you recall this memory? Can you see a clear "snap shot" of what happened?	No specific senses – No snapshot memory.	RSM Negative
	Yes. Clear snapshot memory.	Go To Question 7
Question 7 When you are remembering this frightening experience, do you notice any physical changes in yourself? What do you notice?	No specific somatic symptoms.	RSM Negative
	Yes, changes in heart rate, muscle tension, breathing or any other physiological arousal response.	Go to Question 8
Question 8 Can you remember how you felt at the time of the event? What emotions were you feeling?	No recall or no specific emotional reaction	RSM Negative
	Yes. Emotions relating to fear and helplessness.	RSM Positive.

3.1.4 Procedure

Participants were provided with an information sheet and a Consent Form (Appendix J) prior to testing. Each participant was tested individually in a laboratory setting with two raters present at each testing session. One rater per participant administered both the PIM-SSI and the RSM-SSI. Rater 1 and Rater 2 alternated in the role of administering the interviews (Rater 2 administered the PIM-SSI and RSM-SSI to every second participant). All participants were tested over three sessions. The first session (Time 1) and the second session (Time 2) were conducted 30 minutes apart and testing session three (Time 3) was conducted one week later to yield data for intra-rater reliability analysis.

Participants were read the instructions for the PIM-SSI (Appendix K), and were instructed to vocalise any changes to the i-Test visual stimulus during the 45-second testing period. The participants were required to place their chins on the chin-rest and forehead against the padding on the viewing frames. Once comfortable, the participants were asked to cover one eye with the palm of the hand in accordance with methods described by Tym et al. (2000). If a PIM positive response was indicated during the first 30 seconds, the metronome was initiated and participants were asked to alter the rate of the tone to match the oscillation rate of the perceived movement. The metronome computer display was not in view of the participant. The experimenter recorded all reported

symptoms and the procedure was repeated with the other eye after a short rest period.

After the PIM-SSI was completed for both eyes, the participants were administered the RSM-SSI. The nominated rater read the instructions for the RSM-SSI to the participants (Appendix L) prior to the commencement of the assessment. Under circumstances where a participant could not recall a fearful memory, the RSM-SSI was not administered. The RSM-SSI was always administered after the PIM-SSI in accordance with produces outlined by Tym in the original clinical study (Personal Communication, 2001). It was argued that the assessment of RSM could induce anxiety states that may impact on the assessment of PIM. Additionally, the experimenters knowledge of the participants RSM status prior to administering the i-Test could lead to an increase in experimenter bias (and therefore an increase in false positive PIM classifications).

3.2 Results

3.2.2 Base Rates of RSM and PIM

The base-rates for co-rated PIM (i.e., where Rater 1 and Rater 2 agreed on the classification of PIM) was 7 participants out of the total sample of 50 (14%) at Time 1, 8 out of 50 (16%) at Time 2 and 10 out of 50 (20%) at Time 3. The frequency of co-rated RSM at Time 1 was 9 out of 50 (18%) for Time 1, 2 and 3.

3.2.3 Rate of PIM Oscillations

The mean average rate of PIM oscillations at Time 1 was 0.77Hz (*SD* = 0.071). This rate remained relatively consistent at subsequent testing sessions, with a mean average of 0.75Hz (*SD* = 0.09) and 0.76Hz (*SD* = 0.12) and Time 2 and Time 3 respectively.

3.2.4 Concordance Between PIM and RSM

3.2.4.1 Time 1 Concordance

Table 11

PIM and RSM Cross-Tabulation at Time 1

			RSM		
			Negative	Positive	Total
PIM	Negative	Count	39	4	43
		Expected Count	35.3	7.7	43..0
		% within PIM	90.7%	9.3%	100.0%
		% within RSM	95.1%	44.4%	86.0%
		% of Total	78.0%	8.0%	86.0%
	Positive	Count	2	5	7
		Expected Count	5.7	1.3	7.0
		% within PIM	28.6%	71.4%	100.0%
		% within RSM	4.9%	55.6%	14.0%
		% of Total	4.0%	10.0%	14.0%
Total		Count	41	9	50
		Expected Count	41.0	9.0	50.0
		% within PIM	82.0%	18.0%	100.0%
		% within RSM	100.0%	100.0%	100.0%
		% of Total	82.0%	18.0%	100.0%

From the 7 co-rated PIM positive cases at Time 1, 5 (71.4%) were also classified at RSM positive. Out of the 9 participants that met the criteria for RSM at Time 2, 5 (55.5%) also met the criteria for PIM. A chi-square analysis with Yates' correction for continuity reveals that the observed distribution of cases is unlikely to be due to chance [x^2 (1, N= 50) = 11.81, p = 0.001]. The strength of

the association between PIM and RSM was statistically significant, with a positive Phi coefficient of .561 (p = .0001).

3.2.4.2 PIM and RSM Cross-Tabulation at Time 2

Table 12

PIM and RSM Cross-Tabulation at Time 2

			RSM		
			Negative	Positive	Total
PIM	Negative	Count	38	4	42
		Expected Count	34.4	7.6	42..0
		% within PIM	90.5%	9.5%	100.0%
		% within RSM	92.7%	44.4%	84.0%
		% of Total	76.0%	8.0%	84.0%
	Positive	Count	3	5	7
		Expected Count	6.6	1.4	8.0
		% within PIM	37.5%	62.5%	100.0%
		% within RSM	7.3%	55.6%	16.0%
		% of Total	6.0%	10.0%	16.0%
Total		Count	41	9	50
		Expected Count	41.0	9.0	50.0
		% within PIM	82.0%	18.0%	100.0%
		% within RSM	100.0%	100.0%	100.0%
		% of Total	82.0%	18.0%	100.0%

From the 8 co-rated PIM positive cases at Time 2, 5 (62.5%) were also classified as RSM positive. Out of the 9 participants that met the criteria for RSM at Time 1, 5 (55.5%) also met the criteria for PIM. A chi-square analysis with Yates'

correction for continuity reveals that the observed distribution of cases is unlikely to be due to chance [x^2 (1, N=50) = 9.44, p = 0.002]. The strength of the association between PIM and RSM in this sample was significant with a Phi coefficient of .506.

Table 13

PIM and RSM Cross-Tabulation at Time 3

			RSM		
			Negative	Positive	Total
PIM	Negative	Count	37	3	40
		Expected Count	32.8	7.2	40..0
		% within PIM	92.5%	7.5%	100.0%
		% within RSM	90.2%	33.3%	80.0%
		% of Total	74.0%	6.0%	80.0%
	Positive	Count	4	6	10
		Expected Count	8.2	1.8	10
		% within PIM	40.0%	60.0%	100.0%
		% within RSM	9.8%	66.7%	20.0%
		% of Total	8.0%	12.0%	20.0%
Total		Count	41	9	50
		Expected Count	41.0	9.0	50.0
		% within PIM	82.0%	18.0%	100.0%
		% within RSM	100.0%	100.0%	100.0%
		% of Total	82.0%	18.0%	100.0%

From the 10 co-rated PIM positive cases at Time 3, 6 (60%) were also classified at RSM positive. Out of the 9 participants that met the criteria for RSM at Time 3, 6 (66.7%) also met the criteria for PIM. A chi-square analysis with Yates' correction for continuity reveals that the observed distribution of cases is

unlikely to be due to chance [x^2 (1, N= 50) = 11.59, p = 0.001]. The strength of the association between PIM and RSM in this sample was significant with a Phi coefficient of .547.

3.2.4.4 Onset Times for PIM

At Time 1, the 7 participants who reported PIM had a mean onset of 8.38 seconds (*SD* = 2.326 seconds). The onset time decreased slightly at Time 2, with 8 participants reporting PIM with an average onset time of 7.75 seconds (*SD* = 2.315 seconds). At the final testing session (Time 3), 10 participants reported PIM with a mean onset of 7.60 seconds (*SD* = 2.757 seconds). The total range for PIM onset over three testing sessions was 5 to 15 seconds.

3.2.4.5 Descriptions and Rates of Non-PIM illusions

The following symptoms were co-rated from participant's responses at Time 1.

01 NPIM	The Non-Persistent Illusion of Movement: The target figure appeared to move rhythmically, but did not persist for the duration of the viewing time. This symptom was reported by 4% of the total sample (2% of the total sample reported NPIM in both eyes).	4%
02 SDST	Stationary shadows: An illusionary darker border appeared around or within the yellow rectangle. The dark border or line appeared stationary (6% of the total sample reported SDST in both eyes).	20%
03 NPSM	Non-Persistent/Rhythmical Shadow Movement: The illusionary shadow surrounding the target figure appeared to drift or move non-rhythmically and did not persist (0% of the total sample reported NPSM in both eyes).	2%
04 PSM	Rhythmical/Persistent Shadow Movement: The illusionary dark border appears to move side to side persistently and rhythmically (2% of the total sample reported PSM in both eyes).	6%
05 DFT	Drift: The target figure appeared to move non-persistently and non-rhythmically (2% of the total sample reported DFT in both eyes).	4%
06 FTB	Fade to Black: The target figure appeared to fade into the background before reappearing momentarily(4% of the total sample reported FTB in both eyes).	10%
07 PFTB	Persistent Fade to Black: The target figure appeared to fade into the background and reappear persistently (2% of the total sample reported PFTB in both eyes).	2%
08 HAL	Halo Effect: An illusionary border of bright yellow appears to extend from the target edges (10% of the total sample reported HALin both eyes).	16%
09 TDE	Three Dimensional Effect: Part of the target appeared closer than the rest of the figure, giving a three dimensional appearance (2% of the total sample reported TDE in both eyes).	4%
10 SCH	Shape Change: The yellow rectangle appeared to change shape momentarily (e.g., to look circular), without the appearance of being three-dimensional(0% of the total sample reported SCH in both eyes).	6%
11 BLR	Blurriness: The target figure appeared out of focus for an extended (5 seconds or more) period of time (8% of the total sample reported BLR in both eyes).	8%

3.2.5 Inter-Rater Reliability Analysis

3.2.5.1 Inter-Rater Reliability for PIM-SSI

The intra-class correlations for PIM-SSI for the purposes of establishing inter-rater reliability are presented in the following table.

Table 14

Inter-Rater Reliability for PIM-SSI

	ICC	95% Confidence Interval		Significance Level
		Lower Bound	Upper Bound	
Interrater				
T1	.9231	.8688	.9555	.0000
T2	.9305	.8811	.9599	.0000
T3	.9363	.8908	.9633	.0000

The ICC coefficients exceed .9, which indicates a high level of agreement between raters across all three testing sessions (Portney & Watkins, 2000).

3.2.5.2 Inter-Rater Reliability for RSM-SSI

The intra-class correlations for RSM-SSI for the purposes of establishing inter-rater reliability are presented in the following table.

Table 15

Inter-Rater Reliability for RSM-SSI

	ICC	95% Confidence Interval		Significance Level
		Lower Bound	Upper Bound	
Interrater				
T1	.7219	.5566	.8322	.0000
T2	.7705	.6275	.8631	.0000
T3	.8775	.7941	.9285	.0000

The ICC coefficients for RSM-SSI are slightly lower than PIM-SSI, ranging from .72 to .88 across the three testing periods. Analysis of inter-rater reliability using Kappa yielded the same coefficients as the ICC analysis. Inter-rater correlation coefficients above .7 are considered high enough to establish good inter-rater reliability (Gardner, 1995).

3.3.5 Intra-Rater Reliability Analysis

3.3.5.1 PIM Status at 30-minute Interval

From the 7 participants reporting PIM at Time 1, all 7 (100%) reported PIM at a 30-minute interval. 1 participant reported PIM at Time 2 without reporting it at Time 1.

Table 16

PIM Status at Time 1 versus Time 2

			PIMT2		
			Negative	Positive	Total
PIMT1	Negative	Count	42	1	43
		Expected Count	36.1	6.9	43.0
		% within PIM	97.7%	2.3%	100.0%
		% within RSM	100%	12.5%	86.0%
		% of Total	84.0%	2.0%	86.0%
	Positive	Count	0	7	7
		Expected Count	5.9	1.1	7.0
		% within PIMT1	.0%	100.0%	100.0%
		% within PIMT2	.0%	87.5%	14.0%
		% of Total	.0%	14.0%	14.0%
Total		Count	42	8	50
		Expected Count	42.0	8.0	50.0
		% within PIMT1	84.0%	16.0%	100.0%
		% within PIMT2	100.0%	100.0%	100.0%
		% of Total	84.0%	16.0%	100.0%

Note: PIMT1 = PIM Status at Time 1, PIMT2 = PIM Status at Time 2.

3.3.5.2 PIM Status at 1 Week Interval

Table 17

PIM status at Time 2 Versus Time 3.

			PIMT3		
			Negative	Positive	Total
PIMT2	Negative	Count	39	3	42
		Expected Count	36.6	8.4	42.0
		% within PIM	92.9%	7.1%	100.0%
		% within RSM	97.5%	30.0%	84.0%
		% of Total	78.0%	6.0%	84.0%
	Positive	Count	1	7	8
		Expected Count	6.4	1.6	8.0
		% within PIMT2	12.5%	87.5%	100.0%
		% within PIMT3	2.5%	70.0%	16.0%
		% of Total	2.0%	14.0%	16.0%
Total		Count	40	10	50
		Expected Count	40.0	10.0	50.0
		% within PIMT2	80.0%	20.0%	100.0%
		% within PIMT3	100.0%	100.0%	100.0%
		% of Total	80.0%	20.0%	100.0%

Note*: PIMT2 = PIM Status at Time 2, PIMT3 = PIM Status at Time 3.*

From the 8 participants who reported PIM at Time 2, 7 (87.5%) reported PIM one week later (i.e., Time 3). Out of the 42 participants that did not report PIM at Time 2, 3 (7.1%) reported PIM at Time 3.

Over the three testing periods, 40 out of 50 participants retained a negative diagnosis for PIM, whereas 7 out of 50 retained a positive diagnosis for PIM. Overall, 94% of participants retained the same diagnosis over the three testing periods. One participant was diagnosed a PIM negative at Time 1 and PIM positive at Time 2. Another two participants were classified as PIM negative at Time 2 and PIM positive at Time 3. This suggests that repeated testing may increase the likelihood of participants reporting PIM.

3.3.5.3 Intra-Rater Reliability for PIM-SSI Over 3 Testing Periods.

The ICC for rater one over the three testing periods was .817. The second rater demonstrated a lower consistency across the three testing sessions, with an ICC of .667 as demonstrated in the following table.

Table 18

Intra-Class Correlations for the Intra-Rater Reliability of the PIM-SSI

	ICC	**95% Confidence Interval**		**Significance**
		Lower Bound	**Upper Bound**	**Level**
Intra-rater				
R1	.8172	.7275	.8846	.0000
R2	.6670	.5300	.7805	.0000

Note: *R1 = Rater One, R2 = Rater Two.*

3.3.5.4 RSM Status at 30-Minute and 1 Week Intervals

The frequency and cell distribution for co-rated RSM did not change between the 30-minute testing interval, nor the one- week testing interval.

Table 19

RSM status at Time 1 Versus Time 2.

			RSMT2		
			Negative	Positive	Total
RSMT1	Negative	Count	41	0	41
		Expected Count	33.6	7.4	41.0
		% within RSMT1	100.0%	0%	100.0%
		% within RSMT2	100.0%	0%	82.0%
		% of Total	82.0%	0%	82.0%
	Positive	Count	0	9	9
		Expected Count	7.4	1.6	9.0
		% within RSMT1	0%	100.5%	100.0%
		% within RSMT2	0%	100.0%	18.0%
		% of Total	0%	18.0%	18.0%
Total		Count	41	9	50
		Expected Count	41.0	9.0	50.0
		% within RSMT1	82.0%	18.0%	100.0%
		% within RSMT2	100.0%	100.0%	100.0%
		% of Total	82.0%	18.0%	100.0%

Note: *RSMT1 = RSM Status at Time 1, RSMT2 = RSM Status at Time 2.*

The above table indicates that the intra-rater classification of RSM was perfect between Time 1 and 2. The contingency table for the 1-week interval is identical to Table 19 above.

3.3.5.5 Intra-Rater Reliability for RSM-SSI over Three Testing Periods

The results for the intra-rater reliability testing of the RSM-SSI are presented in the following table.

Table 20

Intra-Class Correlations for the Intra-Rater Reliability of the RSM-SSI

	ICC	95% Confidence Interval		Significance
		Lower Bound	Upper Bound	Level
Intra-rater				
R1	.8860	.8256	.9294	.0000
R2	1.0000	1.0000	1.0000	.0000

Note: *R1 = Rater One, R2 = Rater Two.*

Table 20 demonstrates a relatively consistent classification of RSM over the three testing periods with ICC coefficients above .88. Rater two demonstrated perfect classification of RSM over the three testing periods.

3.3 Discussion

3.3.1 Inter-Rater Reliability

The test of inter-rater reliability for PIM-SSI yielded ICCs above 0.9 at all three testing sessions. This indicates a high level of inter-rater agreement in accordance with guidelines for interpretation set by Landis and Kock (1977). This high level of inter-rater agreement was expected due to the structured nature

of the scoring key (see Appendix H) used in the coding of PIM-SSI responses. The persistence criterion was the only PIM-SSI item for which raters' differed in their assessment of PIM. This can be explained by the vague definition of "momentary" interruption of movement caused by blinking or eye deviation. If the term "momentary" were to be operationally defined, it would be expected that the inter-rater reliability for assessing PIM would approach perfect agreement.

The inter-rater reliability coefficients for RSM-SSI ranged from 0.718, to 0.875. Although slightly lower than the PIM-SSI, all ICC coefficients exceeded 0.7, which has been suggested as a minimum coefficient required for further data analysis (see Gardner, 1995). The comparatively unstructured nature of the RSM-SSI led to a greater variation in responses and therefore increased variability in inter-rater agreement. The overall ICC coefficients for both PIM-SSI and RSM-SSI were sufficiently high to establish acceptable inter-rater reliability for these measures.

3.3.2 Intra-Rater Reliability

The correlation coefficients for both the PIM-SSI and RSM-SSI are above acceptable levels to establish intra-rater reliability (Portney & Watkins, 2000; see Landis & Kock, 1977; Gardener, 1995 for equivalent Kappa coefficient interpretation). This suggests that the instruments reliably measure PIM and

RSM over time, and implies that the phenomena themselves are stable (i.e., test-retest reliability). This is of particular importance with PIM, as the stability of this perceptual disturbance has not been previously documented other than ophthalmological reports of single cases (Kowal, 1999).

The observed intra-rater coefficients for PIM are comparable to the high level of stability documented in the Autokinetic Phenomenon. Test-retest ratings for the Autokinetic Phenomenon have been documented to be as high as +0.92 after as much as a year follow-up retest (Voth, 1947). While 1-year follow-up data from the i-Test is not available, it does appear that the illusion is stable over a shorter time period. This indicates that the illusion is not likely to be an artefact of random error, as it tends to present in the same individuals over three separate testing sessions.

3.3.3 Content and Face Validity

The PIM-SSI and RSM-SSI have been developed to adhere closely to the original criteria for PIM and RSM in order to accurately replicate the effect in this sample. As discussed in section 2.5, the AMVRQ and PIVMQ instruments used in Study 1 have questionable validity due to the inclusion of items that do not clearly reflect RSM and PIM criteria (i.e., poor face validity). At the early stage of exploratory research into anomalous symptoms such as PIM, the

construction of assessment instruments that demonstrate face and content validity is a crucial step to further investigation.

A preliminary analysis of the base-rates observed in this sample reveal that PIM occurs in approximately 14 to 20% of participants. The base-rates for RSM were similar with 18% of individuals in this sample reporting the memory symptom. These observed rates are similar to the documented clinical and community base-rates obtained by Tym et al (2000). Although changing the method of assessment in order to achieve similar base-rates could be viewed as a methodological limitation, it needs to be emphasised that the questionnaires used in the first study were not based on the methods of assessment used in Tym et al. (2000). The questionnaires used in Study 1 were developed by Tym in order to reduce the influence of experimenter bias on the classification of PIM and RSM. However, these self-administered questionnaires with a limited range of forced choice items had questionable validity and yielded much higher than expected base-rates for PIM and RSM. By reverting to methods of assessment that closely replicate the original Tym study, the observed base-rates approximated those documented by Tym and colleagues.

3.3.4 Limitations

3.3.4.1 Inter-Rater Influence

The possible confound of the behaviour of one rater on the other rater's diagnosis is a potential source of error and a limitation that needs to be considered when interpreting the results. While efforts were made to limit explicit behaviours that may influence the judgement of the alternate rater (e.g., minimising the view of both raters from each-other), such a source of error is difficult to completely ameliorate. Given this, it is likely that the obtained ICC coefficients are a slight over estimation of the inter-rater reliability for the PIM-SSI and RSM-SSI measures.

3.3.4.2 Subject Suggestibility and Carry-Over Effects

The intra-rater coefficients could be influenced by prior experience/expectation. This is relevant considering the effect of memory recall and suggestibility on the nature and form of the Autokinetic Phenomenon (Haines, Farrow & Santos, 1977). It has been found that the movement in the Autokinetic Phenomenon is largely influenced by subject expectation and suggestibility. Perceptual experiences that are highly influenced by expectation could inflate the observed reliability (and therefore stability) of such phenomenon. Assuming that PIM is similar in properties to the Autokinetic Phenomenon, then the high intra-rater

reliability may be due to the carry-over effects of one observation on subsequent observations.

The effect of one testing session on the following testing session was especially apparent in the assessment of RSM. It is likely that participants' recall of a traumatic memory would be largely influenced by the previous testing session (i.e., the recall was not necessarily of the traumatic memory, but rather of the previous testing session). This type of carry-over effect would be expected to lead to an over-estimation of intra-rater reliability. A longer time period between test-retest sessions would likely lead to a decrease in the observed correlation coefficients. Although this would be likely, the results of the reliably testing establish that both PIM and RSM are reliably elicited over three testing sessions within a one-week time frame. This is the first study to document the stability of these symptoms.

3.4 Summary

The revised assessment of PIM and RSM appears to be content-valid as it clearly reflects the criteria for these symptoms stipulated in Tym et al. (2000). By reverting back to the original interview method of assessment, the observed base-rates for PIM and RSM approached those documented in Tym et al. (2000). As discussed in section 2.5, the use of questionnaires were premature given that no data were collected on the form of other visual symptoms elicited by steady-gaze

at the i-Test stimulus. Other symptoms reported by participants that include movement (e.g., shadow movement) may have confounded the assessment of PIM cases. The use of semi-structured interviews enabled participants to describe their symptoms rather than select from a pre-determined checklist.

The revised assessment interviews used in this study demonstrate high inter-rater and intra-rater reliability. These data suggests that PIM and RSM are relatively stable phenomena, and can be reliability elicited over a one-week test-retest time frame. The measurement of PIM oscillation rate and onset times reveal that this symptom is relatively consistent between subjects. The majority of participants report PIM within ten seconds of fixed gaze at the i-Test stimulus and report the oscillation rate of the rhythmical movement at slightly below one cycle per second. This varied from Tym et al's reported oscillation rate of 1-3Hz, which was obtained through participant's post-hoc estimation of the speed of visual oscillations. Using a metronome enabled accurate measurement of PIM oscillation rate through the synchronisation of visual oscillations with auditory tones.

The results of this study are important in reference to the investigation of mechanisms underlying PIM and RSM presented in Study 3. This is particularly important for the interpretation of data on the effect of increases in pulse-rate on

the observed oscillation rate of PIM. The proposed mechanisms underlying PIM and RSM will be discussed in the following chapter.

Chapter 4

Study Three: Introduction.

4.0 Overview

In the first chapter of this thesis, several potential mechanisms for PIM were discussed. One possible explanation for PIM is that the illusionary movement observed during visual fixation on the i-Test stimulus is an artefact of the assessment procedure. As discussed in sections 2.0.2 and 2.0.3, the lack of appropriate apparatus and unclear assessment procedures in previous investigations could account for the high level of error variance. For example, the absence of head stabilisation equipment along with a non-fixed visual stimulus could lead to perceivable movement that is reported by the subject as PIM. Additionally, the perception of similar forms of visual illusions (e.g., Autokinetic Illusion) is largely influenced by experimenter expectation (Wallace & Garrett, 1973). These expectancy effects could have lead to a spurious relationship between RSM and PIM.

Tym and colleagues (2000) acknowledged the potential of demand characteristics, and subsequent efforts were made by Tym (Personal Communication, 2001) to reduce possible experimental error by developing self-administered questionnaires. These questionnaires were used for the first time in Study 1 (see Chapter 2), and it was found that this form of assessment produced

substantially increased base-rates of PIM when compared to earlier studies (Tym et al., 2000). As little was known about the phenomenology of i-Test elicited symptoms, the use of predetermined items in the PIVMQ may have been premature, and also contributed to explicit demand characteristics through loading effects. The administration of semi-structured interviews (PIM-SSI & RSM-SSI) in Study 2 yielded reliable data on PIM and RSM, with observed base-rates for these symptoms that were comparable to Tym et al. (2000).

Research on PIM and RSM has established that: a) both PIM and RSM appear to co-occur at levels beyond chance; b) that neither symptom is unique to any one psychological disorder (Tym et al., 2000); c) and that both symptoms are reliability elicited in approximately twenty per cent of participants over a thirty-minute and one-week time period. Tym et al. (2000) suggested that the lower concordance rate between PIM and RSM in their community-based study was a result of inconsistent definitions of these symptoms between the clinical and community studies. They further suggested that using the original criteria for PIM and RSM in the community-based sample would yield a concordance rate comparable to the clinical study. This, however, has yet to be empirically tested.

The focus of this present study is to investigate whether PIM and RSM co-occur in a student based sample, and if so, whether the observed concordance is due to common underlying mechanisms. At the present point in time, it is not known

whether a specific feature of RSM is the most salient predictor of PIM status or if both symptoms are related to common mechanisms. In the first chapter, visual and other sensory anomalies have been linked to several psychopathological and associated physiological processes. In particular, physiological arousal, dissociation, and anxiety sensitivity have been implicated in the generation and maintenance of number of perceptual distortions (Grunfeld, et al., 2000). These three processes are also associated with pathological forms of traumatic memories (Nixon, Resnick & Griffin, 2002; Resnick, 1997; Cox, Borger & Enns, 1999; Hunter et al., 2003). An investigation into the relationship between PIM and dissociative anxiety could provide a tentative explanation on why this symptom is more frequently observed in individuals with RSM than others.

The association between dissociative-anxiety processes and PIM does not provide an explanation on what mechanism underlies the illusionary movement. The persistent and rhythmical movement of PIM are two properties that distinguish this form of illusionary movement from others (e.g., from a unilateral drift or non persistent movement commonly reported in both i-Test perceptual task and the Autokinetic Phenomenon). In the first chapter of this thesis, the two major explanations for persistent visual instability were discussed. The first explanation is that ocular movement in synchronisation with the pulse-rate can result in persistent and rhythmical instability (Kowal, 1999). This explanation assumes that the mechanism underlying PIM is peripherally located (i.e., the

origin of disturbance is due to eye movements), and that the differential response to the i-Test is related to an attentional bias towards symptoms associated with cardiac arousal. The other explanation is that the genesis of the visual disturbance is centrally located. The most substantial evidence supporting a central mechanism is the role of cortical arousal in the Autokinetic Phenomenon (Singh & Singh, 1961), and the documented effect of cortical arousal on maintaining visual stability (Coren, 2002). Experimental manipulation of cortical arousal has found a direct and positive relationship between the level of arousal and the degree of visual instability during fixed gaze perceptual tasks (Coren, 2002). Investigating the relationship between PIM, pulse rate and cortical arousal would provide useful information on possible mechanisms underlying the persistent illusionary movement.

There are five general aims of Study 3: 1) To re-assess the concordance and base-rates of RSM and PIM in a student sample using more rigorous methodology; 2) To investigate the relationship between RSM sub-components and PIM; 3) To investigate the relationship between PIM/RSM and theoretically relevant dissociation and anxiety variables; 4) To investigate the relationship between PIM oscillation rate and Pulse-Rate; 5) To investigate the relationship between PIM oscillation rate and cortical arousal through critical flicker thresholds. These research aims are anticipated to provide information on the reasons why PIM occurs more often in persons with RSM, and also uncover the

mechanisms underlying the visual instability in PIM. The background to each of these aims will now be discussed.

4.1 The Relationship between RSM Sub-Components and PIM

The major underlying assumption of previous research by Tym (personal communication, 2001) was that the visual quality of the RSM symptom was the most salient in predicting PIM. This assumption led to the development of the AVMRQ, where the emphasis is placed on the visual aspects of the RSM. In addition to this assumption, Tym suggested that the visual vividness of RSM led directly to the subjective sense of recency, as the clarity of the memory does not fade with time. In the PTSD literature, the link between vividness and sense of recency is well documented (Halligan et al., 2002). In the broader literature, memories that do not follow the usual decay in clarity are often referred to as "flashbulb" memories (Cohen, McCloskey & Wible, 1988) and such memories have been found to be related to the degree of emotional arousal experienced at the time of the initial event (Cohen, et al., 1988). Flashbulb memories are typically described as being highly perceptual and detailed recall of an emotionally charged event, which shares this central characteristic with RSM (Cohen et al., 1988). Despite this broader evidence, there are no data to support the notion that either the visual aspect of RSM, or the subjective sense of recency, are the most salient characteristics of this memory symptom in

predicting PIM. If the vividness feature of RSM is the most significant predictor of PIM, it would suggest visual instability could be linked to higher-order visual imagery mechanisms consistent with the model proposed by Kosslyn (1994). Kosslyn's model suggests that higher-order mechanisms, such as associative memory systems, constantly engage lower-order visual mechanisms. Given this, disruptions to memory systems could feasibly result in disruptions with visual and spatial encoding of afferent visual stimuli. In the broader sense, this implies that disruptions in higher order memory (e.g., RSM) could impact on basic visual functioning (e.g., visual stability). As mentioned before, the saliency of any one particular feature of RSM in predicting PIM status has yet to be empirically tested.

The other two defining features of RSM are that the memory elicits both somatic arousal and subjective anxiety. Although Tym et al. (2000) specified other characteristics of RSM (see section 1.8), these three components are the defining features of this symptom. Other features of RSM, such as availability, elicitation, and intensity are not considered inclusion criteria, because they do not adequately discriminate between this symptom and general memory recall (i.e., they are exclusion criteria). Furthermore, no participants in the first study were excluded from RSM diagnosis based on the availability criterion (i.e., there were no recovered or previously repressed memories in the sample). Likewise, the notion that the memory can be cued, spontaneous or voluntarily (i.e., the

elicitation criterion) or that its intensity is unspecified (i.e., intensity criterion) does not differentiate one participant's mode of recall from another's. Therefore, the three defining features of RSM are: 1) Somatic Arousal; 2) Subjective Anxiety; and 3) A sense of undecayed vividness. As reviewed in the first chapter of this thesis, the literature on anxiety-related visual disturbances has highlighted the role of physiological arousal in producing a range of sensory symptoms (Papp & Gorman, 1995; McNally, 1994; Van Diest et al., 2000). Neither the affective component (i.e., subjective anxiety) of anxious-arousal nor the vividness of fearful memories (i.e., vividness) has clearly been implicated in producing visual sensory disturbances. Based on this, the following hypothesis is proposed.

Hypothesis 1: The somatic arousal component of RSM will be a significant predictor of PIM in this sample.

4.2 The Relationship Between PIM, RSM and Dissociative Anxiety Variables

As reviewed in Chatper 1, Tym et al. (2000) found that PIM and RSM were not specific to any single DSM-IV diagnostic category (see Table 1). One explanation for the observed distribution is that recurring specific memories of fearful events are apparent in a number of psychological disorders. An alternative explanation is that both PIM and RSM are symptomatic expressions of processes associated with a common psychopathological dimension or

construct. For example, dissociative symptoms are apparent across a number of DSM-IV diagnostic categories (Steinberg, 1995). If both PIM and RSM were symptomatic expressions of this construct, then it would explain their nosological distribution as well as their concordance.

4.2.1 Traumatic Memories and Physiological Arousal.

As discussed in Chatper 1, research into the phenomenology of trauma reactions has consistently demonstrated that physiological arousal is an important component in the development of re-experiencing symptoms in PTSD (van der Kolk, 1998; Rothschild, 2000). For example, heightened arousal in the form of peritraumatic panic is a strong predictor of PTSD development (Resnick, 1997), and is closely paired with the re-experiencing symptoms (Woodward, Murbug & Bliwise, 2000). The physiological symptoms accompanying panic are essentially the same as those observed during a flashback experience, leading to the notion that the two phenomena are closely related (Mellman & Davis, 1985).

In addition to displaying panic-like symptoms during flashbacks, persons with PTSD also display heightened baseline levels of arousal (Rothschild, 2000; Woodward et al., 2000). This is particularly evident in the startle response, which occurs independently of re-experiencing symptoms in PTSD (American Psychiatric Association, 1994; Woodward et al., 2000). Given the literature reviewed in the first chapter, there is solid evidence that traumatic re-

experiencing is associated with increases in physiological arousal accompanying the subject anxiety state. Based on the assumption that RSM is a form of traumatic re-experiencing, it is likely that persons reporting RSM will also report anxious-arousal symptoms. Based on this assumption, the following hypothesis is proposed:

Hypothesis 2a: Self-reported levels of anxious-arousal will be a significant predictor of RSM in this sample.

4.2.2 Perceptual Disturbances and Physiological Arousal

As previously mentioned (see section 1.3), cardio-respiratory arousal is an established mechanism responsible for producing a range of visual perceptual disturbances, including those implicated in the derealization experience (Pap & Gorman, 1995; Van Diest et al., 2000). The types of visual perceptual disturbances linked to heightened arousal tend to be transitory and resolve once arousal symptoms diminish (Van Diest et al., 2000). However persons with PTSD display high baseline levels of arousal (American Psychiatric Association, 1994; Nixon, Resnick & Griffin, 2002), which suggests that accompanying perceptual disturbances could persist for as long as the heightened arousal is present. This suggests that persistent visual disturbances (e.g., PIM) could be state markers for the presence of physiological arousal. Given the relationship

between sensory disturbances and physiological arousal, the following hypothesis proposed:

Hypothesis 2b: Self-reported levels of anxious-arousal will be a significant predictor of PIM in this sample.

4.2.3 Perceptual Disturbances and Dissociation.

Another possible explanation for the observed concordance between PIM and RSM is that they are both dissociative symptoms. Dissociation is typically conceptualised as a disintegration of normally integrated mental processes. The disintegration of visual perception from visual memory can lead to subjective reports of unfamiliarity and derealization commonly associated with a dissociative experience. If RSM is considered a dissociative memory symptom and PIM a dissociative perceptual symptom, then the observed concordance between RSM and PIM could be due to a general dissociation mechanism. Indeed the flashback experience is described in terms of memory aspects (i.e., intrusive recollections) and perceptual aspects (i.e., derealization) providing evidence that these symptomatic expressions of normally integrated mental processes can co-occur (see Speigel & Cardena, 1991; Ehlers & Clark, 2000).

Derealization is comprised of two components: perceptual disturbances and a subjective sense that the external world is unreal (American Psychiatric Association, 1994; Steinberg, 1995). The most common of these perceptual disturbances involve vision (Steinberg, 1995). In this sense, derealization is a specific cluster of dissociative symptoms that include perceptual disturbances. It is assumed that persons with high levels of general dissociation are more likely to report derealization symptoms and thus more likely to report visual disturbances (Steinberg, 1995).

It has been found that visual disturbances associated with derealization experiences can be induced by prolonged visual fixation on a stationary stimulus (e.g., Castillo, 1990). Verbal descriptions of these visual disturbances often include some form of illusionary movement (e.g., Deikman, 1966a). As the i-Test is a perceptual task involving prolonged visual fixation, it could be deduced that PIM is a similar visual disturbance to the illusionary movement reported by participants in these earlier experimental studies (Deikman 1966a; Castillo, 1990). It is important to note that the participants in these previous investigations tended to report a subjective sense of dissociation (i.e., DR/DP) accompanying the visual illusionary phenomena. If PIM represents a visual disturbance related to a dissociative process, it would be expected that participants who report PIM would also report high levels of dissociation. Thus the following hypothesis is proposed:

Hypothesis 2c. Self-reported levels of dissociation will be a significant predictor of PIM in this sample.

4.2.4 Traumatic Re-experiencing and Dissociation.

As discussed in detail in section 1.8.2, traumatic re-experiencing is closely associated with dissociation (Speigel, 1984; Speigel & Cardena, 1991; Steinberg, 1995). Persistent levels of heightened dissociation often follow a traumatic event (Noyes & Kletti, 1977; Ehlers & Clark, 2000) and individuals who develop traumatic pathology tend to report high levels of dissociation (Ehlers, Mayou, & Bryant, 1988). The symptom of re-experiencing itself is often described in the literature as a derealization symptom (Speigel & Cardena, 1991). By definition, this implies that traumatic re-experiencing includes some form of perceptual disturbance.

The underlying assumption in the current study is that RSM is a form of traumatic re-experiencing often associated with PTSD. If this is the case, then it would be highly likely that individuals with this symptom also present with higher levels of dissociation. Thus the following hypothesis is proposed:

Hypothesis 2d: Self-reported levels of dissociation will be a significant predictor of RSM in this sample.

4.2.5 Anxiety Sensitivity as a Vulnerability to Reporting Sensory Disturbances and Traumatic Memories.

The notion that PIM and RSM are symptomatic expressions of common underlying dissociative-arousal processes does not explain why only a subset of the general population report these two symptoms. The prevalence rates in the general population for witnessing at least one traumatic event are very high, yet only a small proportion of these people develop trauma pathology (Elliott, 1996). Both high levels of anxious-arousal, dissociation and intrusive recollections of the traumatic event are normal reactions observed in the general population, however in most cases these symptoms resolve and do not present as pathology (O'Brien, 1998). An explanation for this is that there may be vulnerabilities to develop and maintain the sequelae of symptoms observed in people with PTSD. Research into anxiety sensitivity (AS) has suggested that a dispositional fear of anxiety symptoms induced by a traumatic event may explain why some people develop pathological symptoms and others do not (Cox, Borger & Enns, 1999).

AS has also been used to explain individual difference in the reporting of sensory disturbances and other somatic symptoms (Asmundson, Norton, & Veloso,

1999). Furthermore, the degree of adjustment to sensory disturbances such as tinnitus, appear to be strongly associated with levels of anxiety sensitivity (Gerhard & Vretblad, 2000; Gerhard, 2000). This research suggests that high levels of anxiety sensitivity may predispose individuals to negatively interpret the consequences of anxiety symptoms, including sensory disturbances (Gerhard, 2000). For example, persons with PTSD tend to report high levels of anxiety sensitivity, especially as a reaction to the cardinal symptom of re-experiencing (Cox et al., 1999). The fear of cognitive dyscontrol appears to be the most salient sub-factor of AS in the development of PTSD (Halligan, Clark & Ehlers, 2002; Ehlers & Clark, 2000). The fear of cognitive dyscontrol may also predict the development of sensory disturbances linked directly to the anxious-arousal reactions. Consequently both PIM and RSM are likely markers for the presence of this dispositional vulnerability given the effect of AS on anxiety related sensory disturbances and re-experiencing. Based on this evidence, the following hypotheses are proposed.

Hypothesis 2e: Self-reported levels of anxiety sensitivity will be a significant predictor of PIM in this sample.

Hypothesis 2f: Self-reported levels of anxiety sensitivity will be a significant predictor of RSM in this sample.

4.3 The Relationship Between PIM Oscillation-Rate and Pulse-Rate

In section 1.5, a proposed pulsatile mechanism underlying PIM was discussed. The basis of this mechanism is that illusionary movement as the result of neurological damage or illusionary phenomena such as the Autokinetic Phenomenon, involve eye-movements (Leibowitz, Shupert, Post, & Dichgans, 1983; Pola & Martin, 1977; Hoyenga & Benjamin, 1978). Based on the literature, nystagmus appears to be the best explanation for PIM, given that it is an established causal mechanism for oscillopsia and is exacerbated by heightened anxiety (Grunfeld et al., 2000). There have also been isolated observations of nystagmoid movement occurring in post-traumatic anxiety (Rees, 1958) and during the course of psychotherapy (Teitlebaum, 1954). In addition to this, arousal has been implicated in a range of visual-perceptual disturbances. This suggests that PIM might be related to a known arousal mechanism, such as an increase in the heart-rate or psychomotor tremor. Retinal slip caused by the pulse wave along with other sources of bodily movement is collectively referred to as physiological nystagmus (Steinman, Haddad, Skavenski & Wymanm, 1973). Although it is commonly accepted that the pulse wave causes ocular movement, the degree to which this impacts on visual stability is not fully understood.

The notion of the pulsatile mechanism underlying PIM was based on several observations in the literature. These observations include the role of the pulse

wave in other sensory disturbances with similar characteristics (Sanchez, Sennes & Bento, 1999); sensitivity to cardiac changes in specific anxiety disorders (Richards & Bertram, 2000; Gorman & Sloan, 2000); and the documented effects of cardiorespiratory arousal on basic visual functioning (Cameron & Ryan, 1997; Leske & Podgor, 1983). Furthermore, ophthalmological examinations of persons reporting PIM cited the pulse wave as a possible source of the perceived movement (Kowal, 1999), and the oscillation rate of PIM reported in Tym et al. (i.e., 1 to 3Hz) closely resembles the range of the pulse-rate in healthy individuals (i.e., 60 to 180BPM) . Research on the relationship between cardiovascular arousal, anxiety and visual functioning is limited. However several studies have highlighted links between these systems that support the notion of pulsatile PIM. Hence pulsatile movement can account for the various properties of PIM as well as explaining the specificity of this phenomenon to a particular sub-set of the population (i.e., anxious individuals with a tendency to negatively attend to symptoms accompanying arousal).

An aim of this study is to investigate the relationship between PIM oscillation rate and Pulse-Rate to establish whether PIM is associated with cardiogenic movement. The assumption is that if the pulse wave is implicated in ocular movement resulting in PIM, then the rate at which the rhythmical movement is perceived will be synchronised with the pulse rate. Based on this assumption the following hypotheses are proposed.

Hypothesis 3: Amongst participants reporting PIM, there will be a significant positive correlation between PIM oscillation rate and Pulse-rate in both resting and pulse-elevated conditions.

4.4 The Relationship between PIM, RSM and Critical Flicker/Fusion Thresholds.

As reviewed in the first chapter (see section 1.1.7), isolated observations of changes in sensitivity to visual flicker amongst individuals who had experienced traumatic events had led to the notion that this visual function may be linked to traumatic pathology. Changes in visual thresholds can be measured by perceptual tasks such as the Critical Flicker-Fusion Frequency (CFF). An increase in CFF is interpreted as an increase in visual perceptual sensitivity and a lowering of perceptual threshold for flicker.

Krugman's (1947) research into CFF in war veterans establishes this perceptual task as a potentially useful measure of visual sensitivity in PTSD. However, early investigations into CFF and traumatic anxiety often produced contradictory results (e.g., Krugman, 1947; Isaacson et al, 1967), which have resulted in few subsequent investigations. Many early investigations found that shock-induced anxiety tended to lower CFF scores despite solid evidence that arousal inducing

drugs tended to increase CFF (Corr et al., 1994). Furthermore, fatigue, which has often been viewed as the antithesis of arousal, results in similar decreases in CFF (Weber & Grandjean, 1975; Kumashior, 1995; Chia-Fen & Fang-Tsan, 1998). More recent research has suggested that CFF increases in accordance with anxiety levels (Corr et al., 1994), which contradicts earlier findings.

There are two major reasons why early research produced such varied results. Firstly, PTSD was not formally recognised and individuals with this condition were often labelled psychoneurotic. As criticised by Issacson, Hutt and Blum (1967), the broad definition of psychoneurotic incorporated a wide range of mild to severe symptoms, and therefore were of little value in investigating associated phenomena or specific individual characteristics. Furthermore, some early investigations defined anxiety in various forms, including trait anxiety (e.g., Spielberger, 1967). It is unlikely that participants classified as highly anxious by trait anxiety measures would manifest increased physiological arousal (e.g., increases in muscle tension, heart-rate and breathing-rate) observed in persons with high state anxiety. Such varied definitions of anxiety may have led to inconsistent and contradictory results in early CFF research.

The second limitation of early CFF research related to the reliability of the measure. The apparatus used in early research lacked the precision and sensitivity to detect relatively small changes in CFF. Modern CFF devices tend

to rely on computer timing systems to increase the accuracy of the results. In addition to this, a minor limitation included the lack of controls for the use of psychoactive drugs and alcohol. Alcohol intoxication has been found to be prevalent in persons with traumatic anxiety pathology, and impacts directly on CFF scores (Malfara, 1972).

Whilst the use of CFF in clinical research is limited, its use in human performance research is well established. In its general use, CFF is considered an indicator of the level of CNS excitability, or what is commonly termed "cortical arousal" (Curran, 1990). Subsequent research has established links between cortical arousal and a range of behavioural disorders (e.g., Bonato, 1998; Beh, Mathers, & Holden, 1997). Cortical arousal has been viewed by some authors as a sub-factor of a general arousal construct (Corr, Pickering & Grey, 1994).

A particularly relevant study by Coren (2002) found that caffeine increases cortical arousal and leads to a greater degree of perceptual instability in the visual field. He found that participants reported visual-perceptual instability during steady gaze at a grid line stimulus after consuming 100 or 200 milligrams of caffeine. Increasing dosages of caffeine were associated with greater visual instability, which Coren suggested was the result of increasing levels of cortical arousal. An implication of this research is that visual instability may be an

effective way of easily assessing the level of cortical arousal in a number of contexts (Coren, 2002). As caffeine has also been associated with increases in CFF (Corr, Pickering & Gray, 1994), it is possible that the perceptual instability observed in PIM is related to cortical arousal.

The relationship between CFF and anxiety has not been extensively researched beyond early experimental studies. Moreover, the relationship between flicker/fusion sensitivity and specific anxiety symptoms (e.g., traumatic memories) has yet to be formally investigated. It is unknown whether specific features of traumatic anxiety (e.g., dissociation, intrusive memory or anxious-arousal) account for the observed changes in flicker sensitivity documented in previous research on traumatic anxiety (Krugman, 1947; Goldstone, 1955; Wagoner, 1960). This study aims to investigate the relationship between PIM, RSM and CFF to determine whether changes to visual sensitivity linked to cortical arousal can explain the occurrence of visual instability in persons with traumatic memories.

A significant relationship between RSM and CFF would support the notion that traumatic re-experiencing is related to lower perceptual thresholds (i.e., increased visual sensitivity). Furthermore, if PIM is indicative of higher CFF scores, then cortical arousal may be implicated as a mechanism responsible for producing illusionary movement. The final aim of this study is to investigate whether a

significant relationship exists between PIM, RSM and CFF. Based on recent research on the relationship between anxious-arousal and CFF, the following hypotheses are proposed.

Hypothesis 4a: There will be a significantly higher CFF threshold in individuals with PIM when compared to individuals without PIM.

Hypothesis 4b: There will be a significantly higher CFF threshold in individuals with RSM when compared to individuals without RSM.

4.6 Summary

The current study aims to test several hypotheses regarding the relationship between RSM and PIM as well as the association between these symptoms and theoretically relevant variables. It is expected that an understanding of the relationship between PIM, RSM and dissociation, anxiety sensitivity and anxious arousal will help explain the observed concordance between PIM and RSM. In addition to this, testing the mechanisms underlying PIM would help explain the differential response of a particular sub-set of particpants' to the i-Test perceptual task. At this stage, the pulsatile explanation (i.e., that the rhythmical and persistent nature of the illusionary movement in PIM is best accounted for by central nystagmus in synchronisation with the pulse-wave) has the best support.

Based on the aims there are four sets of hypotheses. The first hypothesis relates to the sub-components of RSM in predicting PIM (i.e., Hypothesis 1); the second group of hypotheses relate to the association between PIM, RSM and dissociative-anxiety variables (i.e., Hypotheses 2a to 2f); the third hypothesis relate to the association between PIM oscillation rate and pulse-rate (Hypothesis 3); and the fourth group of hypotheses are based around the relationship between PIM, RSM and flicker thresholds (Hypotheses 4a & 4b). The method of data collection and analysis will be discussed in the following chapter.

Chapter 5

Study Three: Methodology.

5.0 Design

Study 3 consists of a cross-sectional design, utilising both between and within-subjects designs in order to test the hypotheses specified in Chapter 4. The first hypothesis proposed a significant relationship between the physiological arousal sub-component of RSM and PIM status, and was assessed using Multiway Frequency Analysis. The proposed relationship (see Hypotheses 2a to 2f) between dissociation, anxiety-sensitivity, anxious-arousal (covariates) with PIM and RSM status (outcome variables) was assessed using logistic regression analysis.

A between-subjects design was used to compare participants with PIM and RSM of CFF thresholds (i.e., Hypotheses 4a & 4b). In addition to the between-subjects comparisons, a within-subjects correlational design was used to test the proposed linear relationship between PIM oscillation-rate and pulse-rate (i.e., Hypothesis 3).

5.1 Participants

The sample consisted of 148 participants (74 Male, 74 Female, Mean Age = 22.9 years, *SD* = 5.99 years), who were recruited from a university population via university advertisements, student electronic mail and announcements at lecture

theatres. The sample size for this study was determined in accordance with the process described in section 2.3.1. A research assistant was employed to independently recruit participants and provide initial screening of suitability for the project (i.e., age and health status). The research assistant was naive to the aims and hypotheses for the study in an attempt to reduce sampling bias.

For inclusion in Study 3, participants were required to be 18 years of age or older and to have normal to corrected vision. Participants were excluded from the study if they: a) were aware of pre-existing illness that put them at risk during physical exertion, b) had non-corrected visual abnormalities; c) had used drugs (including tobacco and caffeine) or alcohol 12-hours prior to testing; and d) were included as participants in Study 1.

Four participants were excluded from the sample prior to testing due to pre-existing visual disorders (one participant with total blindness in her right eye) or cardiorespiratory illnesses that place them at risk during physical exertion (three participants with severe asthma). These participants were replaced with four participants who met the health requirements of the study (i.e., the participant was not aware of pre-existing health conditions that put him or her at risk during physical exertion and had normal or corrected to normal vision). All participants were naive to the aims of the research and participated on a voluntary basis.

Participants were partially reimbursed (five dollars) for expenses incurred in attending the testing session.

5.2 Power Analysis for Study Three

5.2.1 Determining Power Requirements for Chi-Squared Analysis

The approach to determining the number of participants required to adequately power the chi-squared analysis was based on the same approach as described in Study 1 (section 2.3.1).

5.2.2 Determining Power Requirements for Logistic Regression Analysis

Power Analysis for logistic regression was conducted using Power Analysis Sample Software (PASS, 2002). A logistic regression of a binary response variable on a continuous, with three normally distributed variables with a sample size of 150 observations achieves .77 power at a 0.05 significance level to detect a change in Prob(Y=1) from the value of 0.05. This change corresponds to an odds ratio of 0.17, which indicates a medium effect size. An adjustment for multicollinearity was made since a multiple regression of one independent variable of interest on the other independent variables in the logistic regression obtained an R-Squared of 0.16.

5.2.3 Determining Power Requirements for Analysis of Variance

A 2 x 2 Analysis of Variance (ANOVA) will be utilised to assess the between group differences in CFF thresholds. An ANOVA set at the alpha level of 0.05 (Power = 0.8) requires a total sample of 128 participants in order to adequately

gauge a medium (Cohen's f = .25) sized effect (Erdfelder, et al, 1996) A sample of 150 participants would sufficiently power the ANOVA analysis in this design.

5.2.4 Determining Power Requirements for Pearson's Correlation Analysis

A one-tailed correlation design (Person's Correlation) will be utilised to test the relationship between PIM Oscillation Rate and Pulse-Rate. The power requirements for a large effect (Cohen's r = .50)[1] at the alpha level of 0.05 (and power set to 0.8) would require a total sample of 22 participants (Erdfelder, et al, 1996). Based on a predicted base-rate of 20%, a total sample of 150 participants would be expected to yield 30 PIM positive cases.

5.3 Measures

5.3.1 PIM-SSI & RSM-SSI

The PIM-SSI and RSM-SSI followed the procedure described in Study 2 (see section 3.1.4). The participant responses were recorded in the order they were verbalised. If participants had difficulty describing a visual symptom, they were asked to sketch an illustration on paper after the i-Test was administered.

5.3.2 Dissociative Experiences Scale (DES)

The Dissociative Experiences Scale (DES) is a 28-item self-report measure of dissociation (Bernstein & Putnam, 1986). The DES items assess a range of

[1] A large effect size was predicted due to the hypothesised relationship between PIM oscillation rate and Pulse Rate. The notion that PIM may be a sensory manifestation of pulsatile movement would suggest a strong correlation between these variables.

dissociative experiences based on the central factors of absorption, dissociative amnesia, and derealization/depersonalisation (Bernstein & Putnam, 1986). Each item describes a dissociative symptom and instructs the participant to rate how often they experience the specific symptom on an 11-point Likert scale (ranging from 0% to 100% at 10% intervals). An example of a DES item includes ‘‘Some people have the experience of not being sure whether things they remember happening really did happen to them or whether they just dreamed them’’. The percentage value of all items are totalled and divided by 28 in order to derive the DES score (Bernstein & Putnam, 1986). Scores above 20 indicate strong dissociative tendencies and scores below 10 are considered to be in the normal range (Carlson & Putnam, 1993; Carlson & Rosser-Hogan, 1993).

The DES is the most commonly used measure of dissociation (Holtgraves & Stockdale, 1997; van Ijzendoorn & Schuengel, 1996), and has good reliability (coefficient alpha of 0.93, and test-retest coefficients range from 0.78 to 0.84). Split half reliability correlations range from .83 to .93 (Bernstein & Putnam, 1986; Pitblado & Sanders, 1991). The DES has good convergent validity (overall Cohen’s d=1.05) in assessing dissociation and traumatic reactions (van Ijzendoorn & Schuengel, 1996). The construct validity of the DES has been supported in several studies that examined the DES score in persons diagnosed with a dissociative disorder (Carlson et al., 1993; Frischholz et al., 1990; Ross et al., 1988). Carlson et al, (1993) established the predictive validity of the DES in

correctly identifying 74% of individuals with Dissociative Identity Disorder in a large clinical population. In summary, there is substantial support for the reliability and validity of the DES in clinical and non-clinical populations. See Appendix M for a copy of the scale.

5.3.3 The Anxiety Sensitivity Index (ASI)

The Anxiety Sensitivity Index (ASI) was developed to test the theory of anxiety sensitivity, which was first described by Reiss and McNally (1985) as the dispositional fear of anxiety symptoms (Appendix N). Anxiety Sensitivity is a construct that predicts behaviours associated with the development of anxiety reactions across all anxiety-based disorders. The ASI is a 16-item measure designed to uncover the extent to which an individual is fearful of anxiety symptoms (Peterson & Reiss, 1992). The 16 items form three basic factors, which include: The fear of physical sensations; the fear of losing mental control[2]; and the fear of the social appraisal of anxiety symptoms. Hierarchical factor analysis of the ASI resulted in one higher-order factor (General Anxiety Sensitivity) and three lower-order factors (Physical Concerns, Mental Incapacitation, and Social Concerns) (Stewart et al., 1997). Normative data for the ASI in an unselected student population indicates a mean AS score of 19.01, with a standard deviation of 9.11 (Peterson & Reiss, 1992). The ASI has been

[2] Fear of losing mental control, fear of mental incapacitation, phrenophobia and fear of cognitive dyscontrol are used interchangeably in the anxiety sensitivity literature. The fear of cognitive dyscontrol (FCD) is the preferred term for this study as it is the most commonly used term in the anxiety sensitivity literature.

shown to have discriminant validity in separating clinical and normal populations, which is consistent with theoretical expectations. The ASI has a Chronbach alpha of .88 (Peterson & Heibronner, 1987), a test-retest reliability of .71 to .75 (Reiss et al., 1986), and is factorially distinct from trait-anxiety in clinical and university-based samples (Taylor et al., 1991).

5.3.4 Mood and Anxiety Symptoms Questionnaire (MASQ) Anxious Arousal Subscale

The Mood and Anxiety Symptoms Questionnaire (MASQ) was developed by Watson and Clark (1991) in order to test the tripartite model of anxiety and depression. The tripartite model proposes that symptoms of depression and anxiety are grouped into three basic factors: Negative Affect (NA), Positive Affect (PA) and Physiological Hyperarousal (PH). Depression is characterized by anhedonia (i.e., high NA and low PA), whereas anxiety is defined by high levels of PH (Watson et al., 1995). Watson et al (1995a, 1995b) administered the MASQ to clinical and student populations in order to investigate the underlying symptom structure. Factor analysis of the MASQ across clinical and community samples revealed three factors corresponding to those postulated by the tripartite model.

The MASQ Anxious Arousal (MASQ-AA) subscale pertains to somatic symptoms associated with state anxiety (Appendix O). The MASQ-AA is

comprised of 17 self-report items describing a range of hyperarousal symptoms that have been experienced in the seven days prior to (and including) the testing session. The respondent is required to rate the extent to which they have experienced a particular symptom on a 5-point Likert scale, ranging from "Not at all" to "Extremely". Sample items include "Felt like I was choking" and "Heart was racing or pounding"

5.3.5 Supplementary Questionnaire

Seven supplementary questions (Appendix P) were administered to participants in order to collect data on the occurrence of migraine headache, motion discomfort, physical fitness, visual disorders, and vestibular symptoms (e.g., dizziness and vertigo). These items were developed to assess whether PIM is directly related to specific visual problems (e.g., astigmatism), neurological (e.g., migraine headache) or vestibular symptoms (e.g., vertigo). The supplementary questions were designed to assess the frequency and severity of these symptoms as reported by the respondents. A five-point Likert response scale comprising the categories of frequency and severity was provided for items one to five. Abnormalities of the visual system were assessed via four categories of visual dysfunction including 1) Short-Sightedness, 2) Long-Sightedness, 3) Astigmatism, 4) Nystagmus. An "other" category was included for abnormalities not appearing in the list. Multiple responses (i.e., to more than one visual dysfunction) were coded accordingly. Participants were asked to specify

the type of "other" visual dysfunction(s), and whether these abnormalities have been corrected by optical aids or surgery.

5.4 Apparatus

5.4.1 i-Test and Viewing Frame

The i-Test stimulus and viewing frame remain unchanged from Study 1 (see section 2.3.4 for detailed description). A stopwatch was again used to standardize exposure time to the i-Test stimulus.

5.4.2 Computerised Metronome

The computerised metronome is the same device used in Study 2 (see section 3.1.3.2 for a description of the device).

5.4.3 Exercise Bicycle with Pulse Monitor

The Monark Electronic Ergometer (model 674E) exercise bicycle was used to elevate and measure the pulse-rate during exercise. The resistance belt and seat height were user adjustable and the pulse-rate was measured using a small computer device mounted on the bicycle handlebars. The pulse-rate computer consisted of a display unit and a remote optical sensor designed to be clipped on the participant's earlobe. The optical sensor gauges the pulse rate through the transmission of light through vascular tissue. Variations in light intensity correspond to changes in blood volume, allowing an accurate measure of pulse-

rate to be determined. The pulse rate is displayed on the LCD screen in beats per minute (BPM), and is averaged over a five second period. The pulse-rate monitor was cross-validated with the Lafayette Heart-Rate Monitor (described below) and found to be a reliable measure of pulse-rate (sampling every 5 seconds over a 2 minute period yielded a correlation of $r(22) = 0.98$, $p < 0.001$ between measures).

5.4.4 Heart-Rate Monitor

Lafayette Instruments (Model 77066C) heart-rate monitor was used to measure the heart rate during the i-Test perceptual task. The heart-rate monitor consists of a central processing (1 ± 0.005% megacycle crystal oscillator) and display unit with a remote optical sensor and is capable of producing a reliable (± 1 BPM) measure of heart-rate over the range of 20 to 200 BMP. The optical sensor is attached to the index finger, and is based on the same principles as the one used on the exercise bicycle. The heart-rate monitor displays a continuously refreshed BPM reading on a LCD panel. The heart-rate monitor also featured an adjustable auditory tone and flashing LED indicator that corresponds to the heart-beat.

5.4.5 Critical Flicker-Fusion Device

A Critical Flicker/Fusion Frequency Device (CFF) device was custom built to provide a measure of critical flicker/fusion frequency. It had been used in previous research into driver fatigue in the Western Australia transport industry

(Hartley, Arnold, Penna, Hochstadt, & Feyer, 1997). A 570-nanometer (nm) liquid energy display (LED) red light was used for the test stimulus. The LED light was placed centrally at the base of a 330mm tube with an aperture diameter of 60mm and was painted flat black to minimize reflection. The stimulus was delivered in square wave alteration at a 1-75 Hz range in 0.25Hz steps. The CFF optical device was attached to an AcerNote (model 735c) notebook computer via parallel port connection. The display allowed for exact and repeatable frequency settings, and the serial port computer interface provided a means for test result storage and computer control of the device. The user options include two modes of operation to cover basic CFF measurement: Ascending Auto Frequency, Descending Auto Frequency Modes. The frequency of the CFF device was calibrated to match the computer's internal timing frequencies, which were utilized by a custom software application to create a data-summary file. The data-summary file contained standard deviation, range and mean CFF scores for each eye. A total CFF score (pre and post-exercise) was also included in the summary data (see Appendix Q for data output).

5.5 Procedure

All participants read an information page (Appendix R1) and signed a consent form (Appendix R2) prior to the commencement of the testing session. The testing session commenced with collecting demographic information, recording baseline pulse-rate and assessing eye-dominance via a fixed-pointing task

(Seteinberg & Parker, 1999). Participants were asked to point to a target located at a distance of approximately 4 meters and to determine which eye is most accurately lined up with the target. Participants were asked to repeat this procedure by pointing with the other hand to reduce the possibility of handedness influencing the result.

Participants were involved in three phases of testing: i-Test assessments (pre- and post-exercise); Questionnaire administration; and Critical Flicker Fusion assessments (pre- and post-exercise). The order of the i-Test assessments and CFF assessments was counterbalanced across 148 participants, with 74 participants completing the i-Test assessments before the CFF assessment and 74 participants completing them in reverse order. Both perceptual tasks (i-Test and CFF) were administered twice in the testing sessions with one in the pre-exercise resting level condition, and the other in the post-exercise testing condition. A booster exercise condition enabled participants to raise their heart-rate to the specified target rate (see Table 22) between the administration of the perceptual tasks.

Table 21

Counterbalanced Order

Participants 1-74	Participants 75-148
PIM-SSI (Pulse-Resting)	Exercise
CFF (Pulse-Resting)	CFF (Pulse-Elevated)
RSM-SSI	Exercise (booster)
Questionnaires	PIM-SSI (Pulse Elevated)
Exercise	Questionnaires
PIM-SSI (Pulse Elevated)	RSM-SSI
Exercise (booster)	CFF (Pulse-Resting)
CFF (Pulse Elevated)	PIM-SSI (Pulse-Resting)

5.5.1 i-Test Administration

Participants were read the instructions for the PIM-SSI, and were instructed to vocalise any changes to the i-Test visual stimulus during the 45-second testing period. The participants were required to place their chins on the chin-rest and forehead against the padding on the viewing frames. Once comfortable, the participants were asked to cover one eye with the palm of the hand. If a PIM positive response was indicated during the first 30 seconds (in accordance with the procedure described by Tym et al., 2000), the metronome was initiated and participants were asked to alter the rate of the tone to match the frequency of the

perceived movement. The metronome computer display was not in view of the participant. The experimenter recorded all reported symptoms and the procedure was repeated with the other eye after a short rest period (except in the post-exercise condition where participants were required to engage in vigorous exercise before testing each eye to assess the impact of increased pulse-rate on the PIM oscillation rate).

After the PIM-SSI was completed for both eyes, the participants were administered the RSM-SSI. The experimenter read the instructions for the RSM-SSI to the participants (Appendix L) prior to the commencement of the assessment. Under circumstances where a participant could not recall a fearful memory, the RSM-SSI was not administered.

5.5.2 Questionnaire Administration

The questionnaires were self-administered, and consisted of standard instructions to the participants (see Appendix M, N and O). The completion of the questionnaires took approximately 25 minutes to complete.

5.5.3 Critical Flicker Fusion Test

CFF was administered after a brief explanation of the device and a practice trial. Instructions and practice trials were part of the CFF computer software and appeared on the computer screen (see Appendix S). Each participant was

instructed to place the index finger of their preferred hand on the CFF button box to minimise measurement error due to response latency (i.e. time between perceiving flicker/fusion and reaching for the button). There were a total of 10 trials per eye (5 ascending & 5 descending) that took approximately 4 minutes to complete per eye. After a short rest-period (of approximately 2 minutes), the participant was asked to repeat the procedure with the other eye.

All participants were tested at baseline levels of physical arousal (pre-exercise) and again after a short period of aerobic exercise (pulse-elevated condition). The level of physical exertion was pre-determined by reaching a target heart-rate at 85% of maximum load (see Table 22). CFF instructions and a practice trial were administered prior to exercise in order to minimise the latency period (i.e., the time between exercise cessation and initiation of the perceptual task). The post-exercise condition (i.e., pulse-elevated) was included in the current study in order to adequately balance the design and control for carry-over effects.

5.5.4 Exercise

Prior to exercise, the i-Test procedure was explained to participants in order to reduce the time between exercise cessation and the initiation of the perceptual task. A target heart rate was based on the participant's age, and set at 85% of maximum load (see Edmund, 2003; American College of Sports Medicine, 2000). The target heart rate was predetermined by the formula: [220 –

Participants Age] x 0.85. Exercise was maintained until the target heart rate was reached or until the participant indicated that they did not wish to continue[3].

[3] Due to ethical reasons, participants who did not wish to exert themselves to the degree required to elevate their heart-rate to the specified target rate were allowed to stop the exercise component at their discretion. The final elevated heart rate was recorded for all cases.

Table 22

Target Heart Rates

Age	Heart Rate Max	85% of Max
18-25	200	170
30	194	165
35	186	160
40	182	155
45	176	150
50	171	145
55	165	140
60	159	135
65	153	130

Once the target heart rate was reached, participants were instructed to maintain the rate for sixty seconds. The experimenter recorded the average BPM during the maintenance period before commencing the i-Test perceptual task.

5.6 Data Analysis

5.6.1 Descriptive Statistics and Basic Concordance Rates

Basic descriptive statistics were employed to document the frequencies and concordance rates for PIM and RSM in the sample. The use of Pearson's Chi Square was employed to examine whether the observed concordance rate between PIM and RSM was significant in this sample. Further analyses of the concordance between RSM, gender and non-PIM illusions also utilised Pearson's Chi Square due to the categorical nature of the variables involved.

An additional aim was to test which sub-component of RSM best predicts PIM status. In this analysis, there are three independent variables (Somatic Arousal, Subjective Anxiety, Undecayed Vividness) and one dependent variable (PIM). A Multiway Frequency Analysis (MFA) was employed due to the dichotomous nature of PIM and the components of RSM. Multiway Frequency Analysis also allowed for an analysis of main versus interaction effects of all three independent variables simultaneously. The use of MFA allows the Partial Chi-Square value of significant sub-components to be compared with the Pearson's Chi Square value for the association between RSM and PIM.

5.6.2 Dissociative-Anxiety Predictors of PIM and RSM Status

A Logistic Regression Analysis (LRA) was employed to test the predictive relationship between DES, MASQ-AA and ASI (predictor variables) with PIM

status (dependent variable). An additional LRA was conducted to test the relationship between the same predictor variables with RSM status (dependent variable). For both analyses, the dichotomous variables gender (Male = 1, Female = 2) and counterbalanced group order (1 for participants 1-74, and 2 for participants 75-148) were entered on the first step, with DES, MASQ-AA, and ASI entered on the second step.

5.6.3 The Relationship between PIM/RSM and Supplementary Variables.

The relationship between RSM/PIM and supplementary variables (Vertigo, Motion Discomfort, Un-Cued Dizziness, Migraine Headaches) was analysed using Univariate Analysis of Variance (ANOVA) to detect between group differences. The relationship between PIM and previously diagnosed eye conditions was assessed non-parametrically via Chi-Square Analysis.

5.6.4 The Relationship between Pulse-Rate and PIM Oscillation Rate.

The relationship between Pulse-Rate and PIM oscillation rate will be assessed by a Pearson's Product Moment Correlation at pre and post-exercise conditions to ascertain whether a significant linear relationship exists between these variables.

5.6.5 PIM, RSM and Flicker Thresholds.

A 2-Way Analysis of Variance (ANOVA) will be employed to detect between group differences in mean critical flicker/fusion threshold scores between PIM

positive and PIM negative groups along with RSM positive and RSM negative groups.

Chapter 6

Study Three: Results and Discussion

6.0 Results

6.1 Descriptive Statistics, Base and Concordance Rates

6.1.1 Base-Rates of RSM and PIM in the Sample

In the total sample of 148 participants, 106 (71.6%) reported having at least one memory of a traumatic incident, but only 28 participants (18.9%) met the criteria for RSM. A total of 24 participants (16.2%) reported PIM in the sample, and of these 24 participants, 17 (70.8%) recalled at least one traumatic event.

In the total sample of 148 participants, 24 (16.2%) reported PIM, and 28 (18.9%) reported RSM. A total of 106 (71.6%) participants reported having at least one memory of a traumatic incident. Of the 24 participants who reported PIM, 17 recalled at least one traumatic event.

Table 23

RSM and PIM Crosstabulation

			RSM		
			Negative	Positive	Total
PIM	Negative	Count	109	15	124
		Expected Count	100.5	23.5	124..0
		% within PIM	87.9%	12.1%	100.0%
		% within RSM	90.8%	53.6%	83.8%
		% of Total	73.6%	10.1%	83.8%
	Positive	Count	11	13	24
		Expected Count	19.5	4.5	24.0
		% within PIM	45.8%	54.2%	100.0%
		% within RSM	9.2%	46.4%	16.2%
		% of Total	7.4%	8.8%	16.2%
Total		Count	120	28	148
		Expected Count	120	28.0	148.0
		% within PIM	81.1%	18.9%	100.0%
		% within RSM	100.0%	100.0%	100.0%
		% of Total	81.1%	18.9%	100.0%

The cross tabulation above indicates that from the 28 participants reporting RSM, 13 (or 46.4%) also reported RSM. Conversely, from the 24 individuals who reported PIM, 13 (or 54.2%) also reported RSM. From the 120 participants who did not report RSM, 109 (or 90.8%) also did not report PIM. A total of 124 participants were classified as PIM negative, and of these cases, 109 (or 87.9%) were also classified as RSM negative. While approximately 54% of participants with PIM reported RSM, only 8% of participants without PIM reported RSM. The observed distribution of cases is unlikely to be due to chance [x^2 (1, N= 148)

= 23.20, p = 0.001]. The strength of the association between PIM and RSM in this sample was significant with a Phi Statistic of .396 (p = 0.001).

6.1.2 Descriptive Statistics for Supplementary Questions

Participants were given a questionnaire (Appendix P) to gain basic information on the frequency of migraine headaches, un-cued vertigo or dizziness, motion discomfort, physical fitness, and any previously diagnosed visual disorders in the sample. One participant out of the total sample did not complete the supplementary questionnaire. Tests of between-subjects effects and frequency of responses are presented in Appendix T. A preliminary analysis of PIM and RSM cases in relationship to the responses on the supplementary items did not yield any significant between group differences, except between RSM positive and RSM negative participants on self-reported frequency of un-cued dizziness or vertigo [*F* (1,146) 14.80, p = 0.001]. PIM did not significantly relate to any previously diagnosed eye disorders (see Appendix T).

6.1.3 The Nature and Base-Rates of Non-PIM Illusions

There were 14 visual symptoms reported by participants that appeared to be sufficiently distinct to warrant separate classifications. The descriptions and base rates listed below were obtained from participants at the pre-exercise condition. Illustrations of the visual symptoms (see Appendix U1) were based on participant sketches (see Appendix U2 for examples) and verbal descriptions.

Table 24

Qualitative Description of Reported Visual Symptoms

Visual Symptom Code	Description	% of Total Sample
01 PIM	The Persistent Illusion of Movement: The central yellow rectangle (target figure) appears to move persistently and rhythmically over the black background (2.7% of the total sample reported PIM in both eyes).	16.2%
02 NPIM	The Non-Persistent Illusion of Movement: The target figure appeared to move rhythmically, but did not persist for the duration of the viewing time. This symptom was reported by 16.9% of the total sample (1.4% of the total sample reported NPIM in both eyes).	16.9%
03 SDST	Stationary shadows: An illusionary darker border appeared around or within the yellow rectangle. The dark border or line appeared stationary (26.4% of the total sample reported SDST in both eyes).	37.2%
04 NPSM	Non-Persistent/Rhythmical Shadow Movement: The illusionary shadow surrounding the target figure appeared to drift or move non-rhythmically and did not persist (16.2% of the total sample reported NPSM in both eyes).	25.7%
05 PSM	Rhythmical/Persistent Shadow Movement: The illusionary dark border appears to move side to side persistently and rhythmically (4.1% of the total sample reported PSM in both eyes)..	9.5%
06 DFT	Drift: The target figure appeared to move non-persistently and non-rhythmically (2.0% of the total sample reported DFT in both eyes).	10.8%
07 FTB	Fade to Black: The target figure appeared to fade into the background before reappearing momentarily(23.0% of the total sample reported FTB in both eyes).	46.6%
08 PFTB	Persistent Fade to Black: The target figure appeared to fade into the background and reappear persistently (2.0% of the total sample reported PFTB in both eyes).	5.4%
09 HAL	Halo Effect: An illusionary border of bright yellow appears to extend from the target edges (37.8% of the total sample reported HALin both eyes).	55.4%
10 TDE	Three Dimensional Effect: Part of the target appeared closer than the rest of the figure, giving a three dimensional appearance (1.4% of the total sample reported TDE in both eyes).	11.5%
11 SCH	Shape Change: The yellow rectangle appeared to change shape momentarily (e.g., to look circular), without the appearance of being three-dimensional(0.7% of the total sample reported SCH in both eyes).	5.4%
12 BLR	Blurriness: The target figure appeared out of focus for an extended (5 seconds or more) period of time(10.8% of the total sample reported BLR in both eyes).	37.8%
13 DIP	Diplopia: There appeared to be two separate and static target figures (1.4% of the total sample reported DIP in both eyes).	4.1%
14 CLR	Colour Change: The target figure appeared to momentarily change colour (e.g. from yellow to red or blue). No participants in the sample reported CLR in both eyes.	4.1%

6.1.4 Concordance

A Pearson Chi-Square conducted on RSM and PIM revealed a distribution of cases that is unlikely to be due to chance [x^2 (1, N=148) = 23.201, p < 0.008][4]. The concordance rate between RSM and PIM was approximately 54%, indicating that a significant proportion of participants that report one symptom also report the other. A Pearsons Chi-Squared analysis on the distribution of PIM and RSM cases is significant when PIM occurs in the right [x^2 (1, N=148) = 14.563, p < 0.008], but not the left eye at the Bonferroni corrected Alpha level of 0.008 [x^2 (1, N=148) = 6.754, p > 0.008].

There was no significant relationship between unilateral PIM and eye-dominance [x^2 (1, N=148) = .001, p > 0.008]. An investigation of the concordance between the 13 non-PIM visual symptoms and RSM yielded no significant relationships (see Appendix V). An analysis of the relationship between gender and PIM did not reveal a significant relationship [x^2 (1, N=148) = .796, p > 0.008], however the relationship between gender and RSM was significant [x^2 (1, N=148) = 14.271, p < 0.008].

[4] Six independent Chi-Square analyses were conducted. The Alpha level of 0.05 was divided by 6 to protect against the inflation of the familywise error rate.

Table 25

Gender and RSM Crosstabulation

			Gender		
			Female	Male	Total
RSM	Negative	Count	51	69	120
		Expected Count	60.0	60.0	120..0
		% within RSM	42.5%	57.5%	100.0%
		% within Gender	68.9%	93.2%	81.1%
		% of Total	34.5%	46.6%	81.1%
	Positive	Count	23	5	28
		Expected Count	14.0	14.0	28.0
		% within RSM	82.1%	17.9%	100.0%
		% within Gender	31.1%	6.8%	18.9%
		% of Total	15.5%	3.4%	18.9%
Total		Count	74	74	148
		Expected Count	74.0	74.0	148.0
		% within RSM	50.0%	50.0%	100.0%
		% within Gender	100.0%	100.0%	100.0%
		% of Total	50.0%	50.0%	100.0%

Of the 28 participants who were RSM positive, 23 were female (82.1%), a proportion unlikely to be due to chance. Data presented in the above table indicates that women (31%) are more likely than men (6.8%) to report a RSM.

The observed distribution of cases is unlikely to be due to chance [x^2 (1, N= 148) = 14.271, p = 0.001]. The strength of the association between gender and RSM in this sample was significant with a Phi Statistic of .311 (p = 0.001).

6.2 The Relationship between RSM Sub-Components and PIM

Hypothesis 1 (section 4.1) related to the relationship between RSM sub-components and PIM status. It was hypothesised that the anxious-arousal property of RSM would significantly predict PIM positive cases. A Multiway Frequency Analysis (MFA) was employed to investigate which of the three sub-components of RSM (Somatic Arousal, Subjective Anxiety, and Vividness) best predicted PIM status. The results indicate that only somatic arousal was significantly associated with PIM status [x^2(1, N=148) = 8.570, p < 0.05].

Table 26
Tests of Partial Associations Between RSM Sub-components and PIM

Effect Name	Partial Chi-Squared	Probability
PIM-Somatic Arousal- Vividness	**5.730**	**.0167***
PIM-Vividness-Subjective Anxiety	2.127	.1448
PIM-Somatic Arousal	**8.570**	**.0034****
PIM-Vividness	.014	.9069
PIM-Subjective Anxiety	.464	.4957

Note: ** Significant at 0.01 level. * Significant at 0.05 level. Significant effects highlighted in bold.

As indicated in Table 26, there was a significant interaction effect observed between Somatic Arousal, Vividness and PIM [$x^2(1, N=148) = 5.730, p < 0.05$], however no main effect was observed between PIM and Vividness [$x^2(1, N=148) = 0.014, p > 0.05$]. The data supports Hypothesis 1: the somatic arousal component of RSM was a significant predictor of PIM in the sample (see Hypothesis 1, section 4.1).

6.3 The Relationship Between PIM, RSM and Dissociative-Anxiety Variables.

In section 4.2, it was hypothesised that PIM and RSM status was predicted by self-reported levels of anxious arousal (Hypotheses 2a & 2b), dissociation (Hypotheses 2c & 2d) and anxiety sensitivity (Hypotheses 2e & 2f). These hypotheses were tested using two separate logistic regression analyses. The results are as follows.

6.3.1 The Predictive Relationship between DES, MASQ-AA, and ASI with PIM

A logistic regression analysis was performed on PIM as outcome and five predictor variables: gender, counter-balanced order, dissociation (DES), anxious arousal (MASQ-AA), and anxiety sensitivity (ASI). Gender and counter-balanced order were entered on the first block as categorical variables and the remaining three predictors were entered on the second block. After deletion of 2

cases with missing values, data from 146 participants were available for analysis: 72 men and 74 women.

A test of the full model with all five predictors against a constant-only model was statistically reliable, $x^2(5, N = 146) = 18.84$, p = .002. indicating that the predictors as a set reliably distinguished between PIM positive and PIM negative cases. The variance in PIM status accounted for is small, with a Nagelkerke R^2 value of .205. The overall model correctly classified 84.2% of participants into PIM positive and PIM negative categories.

Table 27

Variables in the Logistic Regression Equation for PIM

Predictor	B	S.E.	Wald	Sig.
Order(1)	.356	.495	.519	.471
Gender(1)	.525	.500	1.100	.294
MASQ	**.114**	**.041**	**7.518**	**.006**
DES	.012	.023	.272	.602
ASI	.017	.028	.349	.555
Constant	**-6.345**	**1.369**	**21.490**	**.000**

Note: Significant effects highlighted in bold.

Table 27 shows the regression coefficients, standard error, Wald statistics and significance levels for each of the 5 predictors. According to the Wald criterion, only the self reported level of anxious arousal predicted PIM status [Wald x^2 (1, N = 146) = 7.52, p = .006]. The counterbalanced test order did not significantly predict PIM status, which suggests that carry-over effects were not evident in the data. The regression model suggests that participants' self-reported levels of anxious-arousal (i.e., physiological symptoms accompanying anxious states) is the only significant predictor of PIM status. These results support hypothesis 2b: "**Self-reported levels of anxious-arousal is a significant predictor of PIM in this sample".** Hypothesis 2c **"Self-reported levels of dissociation will be a significant predictor of PIM in this sample."** and Hypothesis 2e **"Self-reported levels of anxiety sensitivity will be a significant predictor of PIM in this sample."** were not supported by the data.

6.3.2 The Predictive Relationship between DES, MASQ-AA, and ASI with RSM.

A second logistic regression analysis was performed on RSM as the dependent variable and the same five predictor variables: gender, counter-balanced order, dissociation (DES), anxious arousal (MASQ-AA), and anxiety sensitivity (ASI). As with the previous analysis, gender and counter-balanced order were entered

on the first block as categorical variables with the remaining three predictors were entered on the second block. After deletion of 2 cases with missing values, data from 146 participants were available for analysis: 72 men and 74 women.

A test of the full model with all five predictors against a constant-only model was statistically reliable, $x^2(5, N = 146) = 37.62$, p = .0001. indicating that the predictors as a set reliably distinguished between RSM positive and RSM negative cases. The variance in RSM status accounted for is small, with a Nagelkerke R^2 value of .364. The overall model correctly classified 82.4% of participants into RSM positive and RSM negative categories.

Table 28

Variables in the Logistic Regression Equation for RSM

Predictor	B	S.E.	Wald	Sig.
Order(1)	.583	.503	1.348	.246
Gender(1)	**2.197**	**.629**	**12.205**	**.000**
MASQ	.054	.038	1.997	.158
DES	**.049**	**.023**	**4.397**	**.036**
ASI	.043	.029	2.158	.142
Constant	**-6.999**	**1.482**	**22.321**	**.000**

Note: Significant effects highlighted in bold.

Table 28 shows the regression coefficients, standard error, Wald statistics and significance levels for each of the 5 predictors. According to the Wald criterion, both gender [Wald x^2 (1, N = 146) = 12.20, p = .0001] and self-reported levels of dissociation predicted RSM status [Wald x^2 (1, N = 146) = 4.40, p = .036]. The counterbalanced test order did not significantly predict RSM status, which suggests that carry-over effects were not evident in the data. From the three dissociation and anxiety predictors, the regression model suggests that participants' the self-reported level of dissociation is the only significant predictor of RSM status. These results support hypothesis 2d: "**Self-reported levels of dissociation will be a significant predictor of RSM in this sample.".** Hypothesis 2a **"Self-reported levels of anxious-arousal will be a significant predictor of RSM in this sample."** and Hypothesis 2f **"Self-reported levels of anxiety sensitivity will be a significant predictor of RSM in this sample."** were not supported by the data.

6.4 The Relationship between PIM oscillation rate and Pulse Rate

Hypothesis 3 related to the predicted positive relationship between PIM oscillation rate and pulse-rate. Participants were tested at resting level pulse-rate (pulse-resting) and at an elevated pulse-rate (elevated-pulse) to gauge the effect of increasing pulse-rate on the oscillation rate of PIM.

6.4.1 Assumption Testing for Correlational Analysis

The assumption of normality of residuals for the baseline pulse rate and PIM oscillation rate were confirmed by visual inspection of the normal probability plot (see Appendix W), and a non-significant Shapiro-Wilks statistic. However, the PIM oscillation rate did not adhere to the assumption of normality. This violation has implications for the interpretability of bivariate correlations.

6.4.2 Descriptive Statistics and Base-Rates

The average baseline (pre-exercise) heart rate was 79.89 BPM (*SD* = 13.793) and the mean post-exercise heart rate was 147.77 BPM (*SD* = 12.512). Of the 24 PIM positive participants, 16 (66.6%) of participants reported PIM at the rate of 0.8Hz (*SD* = .1736Hz) at the pre-exercise condition, indicating a low level of variability in PIM oscillation rate between individuals in the data set.

Table 29

PIM Positive Data Summary

Subject Number	Pre-test Pulse	Post-test Pulse	Pre-test PIM Rate	Post-test PIM Rate < 30 seconds	Post-test PIM Rate > 30 seconds
3	63	130	0.8	0	0.8
24	88	135	0.8	0	0.8
25	104	155	0.6	0	0.6
31	68	153	0.4	0	0.4
35	62	135	0.8	0.8	0.8
40	82	148	0.8	0	0.8
44	80	166	0.8	0	0.8
45	81	154	1	0.6	0.8
46	105	174	1.0	0	1.0
47	110	162	0.4	0	0.4
60	78	152	0.6	0	0.6
67	67	147	0.8	0	0.8
68	69	133	0.8	0	0.8
81	92	140	0.8	0	0.8
100	96	152	0.6	0	0.6
103	80	142	0.8	0	0.8
107	92	138	0.8	0	0.8
108	108	156	0.8	0	0.8
114	82	142	0.8	0.8	0.8
119	78	150	1.2	0	1
132	57	155	0.8	0.8	0.8
136	112	168	1.0	0	1.0
137	78	128	0.8	0.8	0.8
138	76	152	0.8	0.8	0.8
Mean	***83.7***	***148.6***	***0.783***	***0.192***	***0.767***
SD	***15.9***	***12.1***	***0.18***	***0.34***	***0.15***

6.4.3 The Relationship between PIM and Pulse Rates

Hypothesis 3 introduced in section 4.3, concern the link between pulse-rate and PIM-oscillation rate. It was predicted that a significant and positive relationship exists between pulse-rate and PIM oscillation rate at both resting level and in pulse-elevated conditions.

6.4.3.1 The Relationship between PIM Oscillation Rate and Pulse Rate within 30 Second Test Period.

A bivariate correlation using Pearson's product-moment on PIM oscillation rates and pulse rates did not indicate a significant positive relationship in either the pre-exercise [$r(22) = -.0.23$, $p = 0.91$] or post-exercise [$r(22) = -.227$, $p = 0.28$] conditions at the 0.05 alpha level. The non-significant and negative correlation appears to be due to the lack of variance in PIM oscillation rate scores.

Table 30

Bivariate Correlations Between PIM Oscillations and Pulse Rate Pre 30 Seconds

	Pulse Rate Condition	
	Pre-test Pulse	Post-test Pulse
Pre-test PIM Rate	-.023	-.027
Post-test PIM Rate	-.369*	-.227

Note: *. Correlation is significant at the 0.05 level (1-tailed).

6.4.3.2 The Relationship between PIM Oscillation Rate and Pulse Rate after 30 Second Test Period.

A bivariate correlation using Pearson's product-moment on PIM and pulse rates did not indicate a significant relationship in either the pre-exercise [$r(22) = -0.39$, $p = 0.855$] or post-exercise [$r(22) = -.012$, $p = 0.956$] conditions at the 0.05 alpha level.

Table 31

Bivariate Correlations Between PIM Oscillation Rate and Pulse Rate Post 30-Seconds

	Pulse Rate Condition	
	Pre-test Pulse	Post-test Pulse
Pre-test PIM Rate	-.039	.017
Post-test PIM Rate	-.016	-.012

6.4.4 The Effect of Pulse-Rate Increase on PIM Oscillation Rate

The increase in pulse rate from the pre to post-exercise condition was significant [$t(23) = 70.744$ $p = 0.001$]. A large proportion of participants (75%) did not report PIM in the first 30-seconds in the post-exercise condition (see data presented in Table 29).

The mean oscillation rate observed in the pre-exercise condition was 0.783 Hz ($SD = 0.18$) compared with 0.767 Hz in the post-exercise condition after 30 seconds ($SD = 0.15$). All 16 participants who were classified as PIM negative in the post-exercise condition reported rhythmical illusionary movement after the

initial 30 - second testing period. It is important to note that the majority of participants reported PIM after the 30-second test period at approximately the same rate as in the pre-exercise condition, indicating an increase in PIM latency rather than an effect on PIM oscillation rate.

6.4.5 Observational Data on Eye-Movements

During both pre and post testing, a small proportion of participants reported difficulty maintaining visual fixation at the i-Test stimulus. This was commonly described by these participants as an awareness of uncontrolled eye-deviation from the target-point during the perceptual task. Furthermore, several participants (particularly Participants 45 and 47) clearly displayed nystagmoid-like eye movements during the i-Test perceptual task and reported difficulties maintaining visual fixation at the target point. The occurrence of these nystagmoid-like movements appeared to coincide with participants' reports of PIM. This unexpected observation will be discussed further in section 6.6.3.

6.5 The Relationship between PIM, RSM and CFF

6.5.1 Assumption Testing for Analysis of Variance & Order Effects

The assumption of normality for pre-exercise and post-exercise CFF was confirmed by visual inspection of the normal probability plot (Appendix X). Equality of error variance was confirmed through a non significant Levene's test [$F(1,3) = 2.29$, $p > .05$], which indicates that the variances of the two groups do not significantly differ. Histograms for CFF indicated relatively normal distribution (Appendix Y). There were no observed order effects between the i-Test perceptual task and the CFF task indicated by a comparison of CFF means

between the counter-balanced groups at the 0.05 alpha level [$t(147)=-1.191$, p = 0.95]. Likewise, the rate of PIM in both counterbalanced groups was statistically non significant [x^2 (1,N=148) = .119, p = 0.656] as demonstrated in the cross-tabulation below.

Table 32

The Frequency of PIM Cases Between Counter-Balanced Groups.

		Counterbalanced Order		
		i-Test First	CFF First	Total
PIM Status	Negative	61	63	124
	Positive	13	11	24
	Total	120	28	148

The distribution of cases displayed in Table 32 suggests that the rate of PIM positive and PIM negative cases do not significantly relate to the order of the perceptual tasks (i.e., whether CFF preceded the i-Test or visa-versa).

6.5.2 CFF, RSM and PIM

A 2 (PIM, non-PIM) x 2 ANOVA (RSM, non-RSM) conducted on CFF (pre-exercise) thresholds demonstrated a significant increase in means thresholds amongst participants with RSM [$F(1,147) = 3.765$, p = 0.05], but no significant difference in CFF thresholds in participants with PIM [$F(1,147) = 1.548$, p = 0.22]. An increase in CFF indicates an increase to sensitivity to flicker at higher

frequencies. The data supports the hypothesis that RSM is associated with increases in sensitivity to flicker (i.e., Hypothesis 4b), but fails to support the hypothesis that a similar relationship exists between PIM and CFF (i.e., hypothesis 4a is not supported). There was no significant interaction effect between PIM and RSM on CFF thresholds [$F(2,147) = 1.919$, $p = 0.17$]. The lack of statistical significance between PIM and CFF could be due low observed power (PIM power = .235, RSM power = .487).

6.5.3 Exploratory Post-Hoc Analysis of RSM Sub-components and CFF

As a significant was found between RSM and CFF (pre-exercise), an analysis of RSM-sub components would be expected to reveal which feature of RSM is related to an increase in flicker sensitivity. An ANOVA conducted on CFF thresholds demonstrated a significant increase in means thresholds amongst participants reported somatic arousal inducing memories [$F(1,147) = 6.371$, $p = 0.013$], but no significant difference in CFF thresholds in participants who reported memories with a subjective sense of anxiety [$F(1,147) = 4.488$, $p = 0.036$] or with highly vivid recall [$F(1,147) = 1.036$, $p = 0.31$] at the Bonferroni corrected alpha level of 0.016.

6.6 Discussion of Study Three Results

6.6.1 Frequencies, Descriptive Statistics and Concordance Rates

The base-rates of PIM and RSM closely reflect the rates reported in the previous community study by Tym et al. (2000). Likewise, the concordance between PIM and RSM are comparable to the previous community-based study (.54 in this

study versus .33 in Tym et al.). The slightly higher strength of the relationship between RSM and PIM when compared to the Tym community based study is likely due to the adoption of the original criteria used for RSM used in Tym et al. (2000) clinical based-study. Tym et al (2000) suggested that with the operational definition for RSM used in the clinical study, the strength of the PIM and RSM relationship in a student sample would be likely to approach that observed in the clinical study (of approximately 0.9). A post-hoc analysis conducted by Tym et al. (2000) on data obtained from the community sample indicated that when PTSD specific criteria were removed from the operational definition of RSM, the concordance rates between RSM and PIM were close to the rate reported in the clinical study. Although a stronger relationship between RSM and PIM was documented in this study when compared to Tym et al. (2000) community-based study, it did not approach the very high concordance documented in their clinical study.

It is also important to note that while approximately half the participants reported both PIM and RSM, the significant effect observed in the distribution of cases can be attributed to participants who do not report either RSM or PIM. This may also explain why a significant effect was found in Tym et al. (2000) community-based study despite a relatively low concordance rate. However, the results of this study do indicate that individuals with PIM are approximately 6 to 7 times more likely to report RSM than individuals who do not report PIM (54%

compared with 8% concordance). This finding does support a relationship between PIM and RSM in a student-based sample.

The gender difference in the base-rate of RSM documented in Tym et al. (2000) study was replicated in this study. Women are four to five times more likely to report RSM than men. As suggested by Tym et al. (2000), this gender difference could be explained by a higher prevalence of emotional disorders (including PTSD) in females. Women demonstrate better access to emotional memories than men, including those of a fearful nature (Tym et al., 2000). The gender difference in PIM was not apparent in this study. There is little evidence of gender differences in the reporting of visual illusionary phenomena in the literature, and those studies that have examined gender differences in the Autokinetic Phenomenon (e.g., Hoyenga & Wallace, 1979) have found that men are more likely than women to report the illusion. The absence of a gender difference in PIM was not unexpected given the lack of empirical evidence beyond the Tym et al. (2000) study to support such a bias, and had not been hypothesised in Chapter 4.

6.6.2 The Relationship between PIM, RSM and Dissociative-Anxiety

The purpose of this part of the second study was to test whether dissociation, anxious-arousal and anxiety sensitivity are significant predictors of PIM and RSM status. It was found that PIM was significantly associated with increased

levels of anxious-arousal (a moderate to large effect size) and RSM was associated with increased levels of dissociation (a moderate effect size). Females were more likely than males to report a RSM, however the relationship between gender and PIM status was not statistically significant. The observed effects should be interpreted cautiously as Nagelkerke values can over-estimate the amount of variance accounted by the predictor variables (REF).

Given the results of the current study, it is likely that the observed concordance between PIM and RSM may reflect the broader relationship between anxious-arousal and dissociative states. This can be extended to explain the specificity of PIM to a specific subset of the population that is characterised by persistent levels of anxious-arousal, hypervigilance for perceptual threat cues, and a tendency to report derealization/depersonalisation experiences (e.g., persons with traumatic pathology). However, this subset of the population is also characterised by high levels of general anxiety sensitivity, which was not significantly related to PIM or RSM in this study. The lack of significance between anxiety sensitivity and PIM status can be explained in several ways. Firstly, issues concerning effect size may have lead to the non-significant results. Due to the lower than expected base-rates for PIM and RSM, there were not enough participants in the sample to detect a medium to small effect size. Secondly, the ASI has been deemed by other authors (see Cox, Borger & Enns, 1999) as limited in assessing the fear of cognitive symptoms accompanying

anxiety (especially in relation to PTSD). As there is well-documented relationship between fear of cognitive dyscontrol and traumatic stress in the literature, the non-significant relationship between general anxiety sensitivity and PIM could be due to a lack of ASI specificity. For example, the inclusion of items regarding fear of social appraisal (specific to social phobia) and fear of cardio-respiratory symptoms (specific to panic disorder) could have weakened the association between general AS and PIM/RSM. Future studies examining this relationship in more detail would benefit from the use of the Anxiety-Sensitivity Index Revised (ASI-R), in which items pertaining to AS sub components have been expanded. At the time of the current study, the ASI-R had not been sufficiently tested in terms of psychometric properties and factor structure. However subsequent analysis (e.g., Zvolensky et al. 2003; Deacon et al., 2003) have established that the ASI-R has good convergence validity on the ASI and comparable reliability. The expanded range of items pertaining to the AS secondary factors (e.g., fear of cognitive dyscontrol) suggests that the ASI-R is a more suitable instrument for investigating differences in AS secondary factors such as FCD.

Finally the cross-sectional design of the study may have captured those participants experiencing transient adjustment to a traumatic event at the time of testing, thus explaining the lack of a relationship with both PIM and RSM. As mentioned in the first chapter, normal reactions to a trauma include frequent

intrusive memories, heightened anxiety and dissociation but not necessarily anxiety sensitivity. Anxiety sensitivity may only become a significant factor in those cases where these symptoms persist and adjustment is problematic. Thus these participants may still experience the sequealae of posttraumatic symptoms (including PIM and RSM), but their dispositional fear of these symptoms is low and therefore does not result in the development of a pathological syndrome.

Stronger evidence for establishing PIM as an arousal symptom was supported by the significant relationship between the somatic-arousal component of RSM and PIM. Both the subjective anxiety and vividness features of RSM had no significant relationship with PIM status per se. This supports the notion that PIM originates from somatic arousal and may be linked to a specific set of discharge phenomena accompanying anxiety states. It is important to note that while somatic arousal was the only sub-component of RSM to significantly relate to PIM status, its predictive power is not as great as RSM as a whole. This indicates that the relationship between RSM and PIM cannot be entirely accounted for by any singular RSM sub-component or combination of RSM sub-components. However, it does support the notion that the origin of PIM could be liked to anxious-arousal mechanisms. The specific mechanism may be linked to cardiogenic, respiratory or neuromuscular (e.g., twitching or tremor) changes associated with hyperarousal.

6.6.3 The Relationship Between PIM Oscillation Rate and Pulse Rate

The data obtained in this study did not support the notion that PIM oscillation rate is synchronised with pulse-rate. On the contrary, the evidence indicates an opposite effect, with the majority of the PIM positive group failing to report PIM in the post-exercise condition under the 30 seconds. As previously noted, the response latency increased in the post-exercise condition, leading to few participants reporting PIM in the initial 30-second time frame (consistent with the original inclusion criteria for persistence stipulated by Tym et al., 2000). Although onset times were not recorded, the few participants that did report PIM in the post-exercise condition only just made the 30 second qualifying period. When compared to the onset times documented in Study 2 (of between 5 to 15 seconds), the increase in PIM latency in the post-exercise condition appears to be a reliable and strong effect.

The increase in PIM latency suggests that aerobic exercise acts to temporarily enhance visual stability, perhaps through the Vestibular Ocular Reflex (VOR) mechanism, which is generally responsible for correcting retinal slip. As stated by Furman and Jacob (2001), arousal enhances the VOR, which in this case may act to effectively negate erroneous movement signals caused by the pulse-wave. Although speculative at this stage, such an explanation would suggest that in persons with PIM, the VOR is not effectively counteracting retinal slip occurring at resting level. Once physiological arousal and corresponding increases in

systemic movement become sufficiently intense, the VOR is initiated to compensate for movements originating from this source. What is unclear is why the VOR is not operating effectively at resting levels of physiological arousal.

The increase in PIM latency is similar to the effect observed in the Autokinetic Phenomenon (Singh & Singh, 1967). After the administration of stimulant drugs, the initiation of the Autokinetic Phenomenon was significantly delayed compared with normal controls and persons administered depressant medication (Singh & Singh, 1967). The authors attributed this change in autokinetic latency to changes in cortical satiation, a term which has been used interchangeably with cortical inhibition or mental fatigue (James, 1967). This explanation would suggest that PIM is a form of the Autokinetic Phenomenon, as it shares several characteristics, such as the nature of the visual stimulus (i.e., a fixation point presented on a homogenous black background) and the illusionary movement itself (e.g., the illusionary movement of the target figure across the black background). However, the notion that persons with high levels of cortical arousal display an increase in autokinetic latency does not explain why anxious individuals are more likely to report PIM at baseline levels of arousal.

The other possible explanation is that the exercise task itself produced a paradoxical effect. The use of exercise in this particular experiment was designed purely to increase the pulse-rate so that changes in the PIM oscillation

rate could be observed. However, other studies have examined anxious-arousal through the use of exercise paradigms, based on the notion that an increase in cardiac output and rate should result in an increase in panic symptoms. However, this effect does not typically occur (O'Connor, Petruzello, Kubitz & Robinson, 1995; Youngsted, O'Conner, Crabbe, & Dishman, 1998). In fact, the majority of participants report a decrease in subjective anxiety symptoms after engaging in aerobic exercise. Various mechanisms have been proposed for the anxiolytic effect of exercise, including the release of endorphins (Morgan, 1985), a decrease in systolic blood pressure (Raglin & Morgan, 1987), or simply due to time out from daily concerns and hassles (Breus & O'Conner, 1988). Transient decreases in anxious symptoms as the result of aerobic exercise could explain the increased onset of PIM in the post-exercise condition.

The increased latency may also be the result of decreased physiological arousal following exercise. Physiological changes following physical exertion may result in a transient decrease in arousal, resulting in an increase in PIM latency. Another explanation for the increased latency is based on findings in the Panic Disorder literature. The physical symptoms elicited by exercise are some of the same symptoms that occur in heightened anxiety states, including increased cardiac rate, respiration and perspiration. Aerobic exercise may provide a means to which interoceptive exposure to feared bodily sensations acts to extinguish the fear-response (Broman-Fulks, Berman, Rabian & Webster, 2003). Difficulties in

eliciting anxious symptoms through the use of aerobic exercise may relate to attribution of physiological symptoms to the task itself. Therefore, at resting levels, anxious-arousal symptoms have no obvious external cause and therefore are more likely to elicit an anxious response. This suggests that anxiety sensitivity may play a role in the reporting of symptoms such as PIM during resting level, but diminish during aerobic exercise. This is supported by recent research, which has found that aerobic exercise can significantly reduce anxiety sensitivity, and that high-intensity exercise produces a rapid decrease in AS (Broman-Fulks, Berman, Rabian & Webster, 2003).

It is important to note that while the pulse hypothesis was not supported in the current study, other aspects of physiological arousal cannot be ruled out as underlying mechanisms of PIM. For example, bodily movement caused by respiration or changes in blood pressure are two possible mechanisms responsible for producing PIM. Breathing rate is a possible mechanism, as it occurs at slower rates than the pulse wave and has been found to influence subjective anxiety states to a greater degree that cardiac sensations in panic (Broman-Fulks, et al., 2003). Thus it is possible that other physiological changes associated with anxious arousal could be linked to PIM.

One unexpected finding was that the reported PIM oscillation rate was relatively homogenous. Tym et al. (2000) documented range of 1 to 3Hz was not

replicated in this study. By using more precise methods, it was found that the majority of individuals reported PIM at the rate of 0.8Hz, which may provide clues to the underlying mechanisms responsible for producing the disturbance. An observation in the present study was that participants reporting PIM consistently experienced difficulty in maintaining fixation on the central target point. In addition to this, there were observations of rhythmical nystagmoid movements in some of the participants reporting PIM. These observations taken together would suggest that some form of eye-deviation might be responsible for PIM. Given the extensive evidence that nystagmus causes oscillopsia in pathophysiological conditions (Lopez, Kremenchutzky & Garcea, 1997; Grunfeld, et al., 2000; Cassin, 1995), and that nystagmoid movements have been observed in posttraumatic anxiety (Rees, 1958), the role of eye-movements in PIM is even further substantiated. Unfortunately, an analysis of ocular-motor functioning is beyond the scope of the current study, and needs to be assessed by future ophthalmological research.

6.6.4 The Relationship Between PIM, RSM and CFF.

The current research supports the hypothesis that individuals with RSM display higher sensitivity to visual flicker than normal controls. This finding supports earlier research on the relationship between arousal and flicker sensitivity (Riccituti, 1947; King, 1962; Isaacson, Hutt and Blum, 1967; Malfara, 1972), and addresses some inconsistent findings on CFF thresholds in traumatic anxiety

(Krugman, 1947; Goldstone, 1955; Wagoner, 1960). The significantly higher CFF in persons with RSM at pre-exercise levels of arousal suggest that resting levels of arousal are higher in these participants. Exercise induced arousal resulted in an non significant difference in flicker thresholds between RSM positive and normal controls, suggesting that anxious arousal is the most salient factor in changes to CFF thresholds. This is further supported by the observation that the somatic arousal component of RSM was the only significant sub-component to relate to CFF. On the whole, the statistically significant rise in CFF threshold suggests that RSM as a memory symptom is associated with increased levels of cortical arousal. However, it is important to note that the small effect size observed in the current study warrants caution in the interpretation of significance, especially with respect to establishing the practical significance of CFF changes as a marker of traumatic memories.

As previous research has suggested that cortical arousal leads to visual-perceptual instability (Coren, 2002), it would be expected that individuals with PIM would have higher CFF thresholds. However, this was not supported by the data. An explanation for the lack of significance is due to relatively low numbers of participants in the PIM positive condition (i.e., insufficient statistical power). Nevertheless, if statistical significance is reached with an increased number of PIM positive participants, the effect size is too small to be of any practical

significance. The data does not support a link between cortical arousal and PIM in this sample.

The findings of this study suggest that recurring memories of a fearful event are associated with significantly increased sensitivity to detecting flicker. As critical flicker frequency is an established index of cortical arousal, these findings suggest that there is a positive relationship between RSM and baseline levels of cortical arousal. The relationship between the arousal sub-component of RSM and CFF further supports the notion that the somatic arousal component of traumatic memories appears be the most salient factor underlying visual-perceptual changes. The relatively small effect size observed in this study does not support the usefulness of CFF in exploring the mechanisms underlying RSM and PIM in a student sample. However, it is likely that pathological forms of traumatic memories, such as those inherent in PTSD, would lead to larger effects on CFF thresholds as documented in earlier research (Krugman, 1947; Isaacson et al., 1967). Future research could aim to clarify the relationship between visual sensitivity, cortical arousal and anxiety symptoms in persons with PTSD.

6.7 Limitations of Study Three

6.7.1 Unequal Group Sizes

The number of PIM and RSM cases in the current study were substantially less than the number of cases where these symptoms were not present. An

implication of unequal group sizes for between group analyses (e.g., the CFF analysis of variance) is reduced statistical power (Gill, 2001). Indeed post-hoc analysis of power revealed low power coefficients, which could explain the lack of significance between PIM and CFF. An implication for interpreting the results of Study 3 is that statistical significance is likely to be underestimated.

6.7.2 Multiple Hypothesis Testing of a Single Sample

The problem of testing multiple hypotheses on a single sample relates to the increased risk that significant effects are reported by chance. In Study 3, groups of hypotheses (i.e., Hypothesis 1, Hypotheses 2a-2f, Hypothesis 3, & Hypotheses 4a-4b) were treated as conceptually independent and alpha protection procedures (i.e., Bonferroni corrections) to control for increases in the family-wise error rate were employed. Despite this safeguard, testing multiple hypotheses does increase the risk of making a Type I error. This increase in error needs to be taken into account when interpreting the significant effects, as it is likely some of the reported effects were significant by chance.

The other problem of multiple hypothesis testing relates to carry-over effects. Participants' exposure to one experiment may have confounded their results on another experiment. Counter-balancing measures were put in place to gauge and control the impact of carry-over effects. As there were two separate perceptual tasks (i.e., the i-Test and the CFF test), half the participants received the tests in

reverse order. An analysis of the mean threshold rates between the counter-balanced group did not indicate a significant carry-over effect from the i-Test perceptual task. Likewise, the rate of PIM positive individuals was approximately the same for each counterbalanced group. Although counterbalancing measures helped determine whether carry-over effects were evident, the most ideal experimental design would utilise a separate sample for each group of hypotheses.

6.8 Summary of Study Three

The general aims of Study 3 were to 1) Reassess the base and concordance rates for PIM and RSM in a student sample; 2) Investigate the relationship between specific sub-components of RSM in relation to PIM status; 3) Explore the relationship between PIM and RSM with dissociation, anxious-arousal and anxiety-sensitivity; and 4) Test the hypothesised relationship between pulse-rate and PIM oscillation rate; and 5) Investigate the relationship between PIM, RSM and critical flicker thresholds.

This study documented a base-rate of PIM and RSM ranging between 16 to 19%. The concordance-rate between these two symptoms was approximately 50%, which is higher than Tym et al. (2000) community based study of approximately 33%, but not as high as the clinical based study of approximately 90%.

In examining the relationship between RSM sub-components and PIM, it was found that the arousal-inducing property of RSM significantly predicted PIM status. This supported Hypothesis 1, which predicted that increased levels of anxious-arousal were related to PIM positive status based on the established link between anxious-arousal and visual disturbances in the literature (Papp & Gorman, 1995; McNally, 1994; Van Diest et al., 2000). Other features of RSM, such as vividness and a subjective sense of anxiety were not independently predictive of PIM status.

It was predicted that RSM and PIM were related to dissociation given the documented links between visual disturbances and traumatic memories in the literature (Ehlers, Mayou, & Bryant, 1998; Murray, Ehlers & Mayou, 2002). In this study, RSM was found to be significantly predicted by dissociation, however no significant relationship between dissociation and PIM was reported. A significant relationship increased levels of self-reported anxious-arousal and PIM classification was supported by the data, however this effect was not evident in RSM cases. Overall, the data suggests high levels of dissociation are significantly predictive of RSM positive cases, whereas high levels of anxious-arousal are significantly predictive of PIM positive cases.

PIM was proposed to relate to movement caused by the pulse-wave, as documented rate of PIM oscillations corresponds to variable range in pulse-rate. Additionally, specific subsets of anxious individuals are more likely to attend toward cardiovascular symptoms which could explain the relatively specificity of PIM to persons reporting anxiety related symptoms (e.g., anxiety inducing memories or RSM). The data from Study 3 did not support a link between pulse-rate and PIM oscillation rate. An increase in pulse-rate did not correspond to an increase in PIM oscillation rate. An unexpected finding in this study was that engaging in brief aerobic exercise increased the PIM latency. After engaging in exercise, the majority of participants did not report PIM within the first 30 seconds of the post-exercise testing period[5]. This was a transient effect, with all PIM positive individuals reporting PIM at approximately the same oscillation rate as the pre-exercise condition after the initial 30 second time period has elapsed.

The last part of this study examined the between group differences between PIM (PIM positive versus PIM negative) and RSM (RSM positive versus RSM negative) in critical flicker/fusion thresholds. Based on the literature, CFF is an index of cortical arousal, and has been documented by early studies to closely relate to the presence of pathological symptoms in traumatic anxiety (Malfara, 1971; Corr, Pickering & Gray, 1995; Grandjean et al., 1977; Grunberger et al.,

[5] The 30-second time period was part of the initial inclusion criteria for assessing PIM stipulated by Tym et al. (2000).

1992). High levels of cortical arousal have demonstrated to lead to visual instability during fixation, which was the basis for the hypothesised relationship between CFF and PIM. The data demonstrated a significant increase in CFF in participants reporting RSM when compared to participants who did not report RSM, however there were no significant differences in CFF between PIM positive and PIM negative individuals.

Overall, the data from this study has established a significant concordance between PIM and RSM, and suggests that PIM is most likely related to physiological symptoms accompanying anxious-arousal irrespective of their RSM status. The specific mechanism underlying PIM, however, remains unknown.

Chapter 7

General Discussion

7.0 Overview

Tym and colleagues had documented a persistent illusionary movement that they claimed was highly predictive of the presence of recurrent specific memories of a fearful event (RSM). Consistent reports of illusionary movement during visual fixation lead to the development of a visual stimulus (the i-Test) to elicit the visual symptom (PIM). Tym et al documented a high rate of concordance (approximately 90%) between PIM and RSM in a clinical sample. The rate was much lower (approximately 33%) in a community-based sample, which Tym et al. (2000) attributed to differences in the operational definition of RSM. Tym and colleagues suggested that the removal of more stringent PTSD specific criteria from the definition of RSM would result in a comparable concordance between community and clinical based samples.

This thesis aimed to document the base and concordance rates for RSM and PIM using the operational definitions stipulated in the Tym et al. (2000) clinical based study. Further from this, a standardised procedure for assessing PIM and RSM was developed in order to increase reliability and reduce experimental error arising from inconsistent methods of assessment. Prior to the research in this

thesis, the reliability of PIM symptoms and the reliability of observed concordance between PIM and RSM were unknown. This thesis also aimed to test possible mechanisms underlying PIM, and to explore the association between PIM, RSM and theoretically relevant variables.

This thesis had four major aims. The first aim was to address methodological inconsistencies in previous research so that reliable and replicable assessment of RSM and PIM could be achieved. This enabled: 1) A meaningful comparison of base and concordance rates with previous and future research; 2) A more detailed knowledge of the properties of PIM and RSM including which feature of this memory symptom best predicts PIM status; and 3) Establishing the reliability of PIM and RSM in a student based sample. The second aim was to investigate factors that account for the observed concordance between PIM and RSM. An examination of the relationship between PIM/RSM and established correlates of traumatic anxiety were expected to highlight processes by which these two symptoms may be linked. The third aim was to test a specific hypothesis regarding the underlying mechanism for PIM. The proposed pulsatile mechanism was hypothesised to account for the properties of PIM (i.e., rhythmicity and persistence) as well as explaining why it is associated with a subset of the population who are characterised by sensitivities to cardiac arousal (Clark, 1988; Cox et al., 1999). An understanding of the mechanism responsible

for signal generation in PIM was expected to provide useful information on its observed specificity to anxiety conditions.

The final aim was to test the association between RSM, PIM and flicker thresholds. As flicker thresholds have been associated with cortical arousal (Curran, 1990) and associated with traumatic anxiety reactions (Krugman, 1947; Goldstone 1955), this study aimed to clarify the nature of this relationship. Early investigations of flicker sensitivity in post-traumatic anxiety disorders yielded contradictory results and required further investigation (Isaacson, 1967). An understanding of the relationship between PIM/RSM and thresholds to flicker were expected to provide evidence for changes in low-level visual functioning in traumatic anxiety. Furthermore, any relationship between PIM/RSM and flicker thresholds would provide preliminary evidence that cortical arousal may play a role in visual instability and recurring traumatic memories.

It was expected that this research would yield valuable information on the nature of PIM and how it is linked to traumatic memories. In a more general sense, these findings were expected to highlight the role of visual symptoms in the expression and maintenance of other clinical features in traumatic anxiety. The following sections summarise the research findings linked to the aforementioned aims.

7.1 Operational Definitions and Properties of PIM and RSM

The first part of this thesis concerned addressing methodological limitations identified in previous research (Tym et al., 2000). The use of more accurate measures along with addressing methodological limitations of previous research have resulted in a greater understanding of the phenomenology of PIM and RSM. In this thesis, PIM was defined as any form of persistent and rhythmical illusionary movement of the i-Test target figure. The definition for RSM was based on the Tym criteria specified in the clinical study. A prediction of Tym et al. (2000) was that the adoption of uniformed criteria for RSM based on their clinical definition would likely result in very high concordance (of approximately 90%) between PIM and RSM in a community-based sample.

The first study utilised questionnaires developed by Tym in order to address the influence of demand characteristics in the assessment of PIM and RSM. The use of these questionnaires was problematic and produced much higher than expected base-rates for these symptoms. An explanation for the high base-rates was related to poor questionnaire design and a lack of data on i-Test elicited visual disturbances other than PIM. For example, commonly reported movement of a dark border surrounding the target figure was not included as an item in the PIVMQ. This would have likely resulted in a higher rate of false-positive responses. Caution is warranted in the use of self-administered questionnaires, as it is established in the perceptual literature that visual illusionary phenomena are

highly susceptible to suggestion (Wallace & Garrett, 1973). In the case of self-administered questionnaires, checklist items may influence the participants' response to the task or recall of the perceptual experience itself.

Similar design limitations and difficulties in item interpretation were evident in the AVMRQ leading to an unacceptably high level of false-positive RSM classifications. These methodological limitations were addressed by reverting to the original criteria (stipulated in Tym et al's clinical study) for PIM and RSM as well as reverting to an interview mode of assessment in studies 2 and 3 of this thesis.

Using structured interviews (PIM-SSI & RSM-SSI) the observed base rate of PIM was found to be comparable to earlier studies, with approximately 16% reporting the disturbance in a student sample. A previously estimated but largely unknown feature of PIM was the rate of movement. It was found that the oscillation rate of PIM is relatively consistent between individuals at approximately 0.8Hz and is initiated within 15 seconds (usually around 7 seconds) of visual fixation under normal conditions. The ICC reliability coefficients for PIM and RSM are all above 0.7, indicating high inter-rater and intra-rater reliability. The intra-rater reliability establishes PIM as a relatively stable phenomenon, with comparable reliability coefficients to those reported in Autokinetic Phenomenon research (Voth, 1947).

Visual fixation on the i-Test stimulus resulted in anomalous visual symptoms in most participants. 12 non-PIM illusions were documented and visual representations were developed from participant descriptions and sketches. It is important to note that some of these symptoms included non-persistent or non-rhythmical movement of the target figure or background. As these visual symptoms share common features with PIM, the failure to adequately differentiate between PIM and non-PIM illusionary phenomena can lead to an increase in error variance (as was observed in Study 1).

PIM appears to be significantly associated with RSM, with a concordance rate of between 48% to 54%. Around half of the participants who reported PIM also reported RSM, which was significantly higher than the rate of RSM in participants without PIM. This rate of concordance was higher than observed in the Tym et al. (2000) community based study and is unlikely to be due to chance.

Tym et al. (2000) documented a gender difference in the base rates of both PIM and RSM in the clinical and community based studies. Although there was no significant gender difference in the base-rates for PIM in this study, there were significantly more women with RSM than men. The result of Study 3 indicate that women are between four to five times more likely to report recurrent specific memories of a fearful event than men. It is likely that gender

differences in the recall of emotional memories and the higher rate of emotional disorders in women best account for these findings. There has been little research conducted on gender differences in the perception of illusionary phenomena, and given this, the absence of a gender difference in PIM is not unexpected.

Another unanticipated finding in this research was that PIM is temporarily inhibited by exercise-induced arousal. Short periods of aerobic exercise appeared to increase the latency of PIM initiation but did not impact on the rate of illusionary movement. It is not clearly understood why aerobic exercise has this consistent effect. However similar findings have been documented in research on the Autokinetic Phenomenon (Singh & Singh, 1967). Singh and Singh suggested that increased latency of autokinetic initiation is related to levels of cortical arousal or conversely cortical satiation. It is plausible that the same mechanism may be responsible for PIM or that PIM itself is a form of the Autokinetic Phenomenon. Alternatively, the use of exercise may provide the participants with an explanation for the arousal symptoms (including visual instability), resulting in a change in response criteria. There is also evidence that even short periods of exercise lead to transient decreases in participants' self-reported levels of anxiety (O'Conner, et al., 1995; Youngsted, et al., 1998), which can explain why PIM is temporarily inhibited if it is an anxious-arousal

concominant. The consistency and strength of the latency effect is significant enough for it to warrant further experimental investigation.

In this study, PIM was related to increased levels of self-reported anxious-arousal. An examination of the sub-components of RSM in relation to PIM also supported this link, with only the physiological arousal component relating significantly to PIM. These findings taken together suggest that PIM is linked to the range of symptoms commonly experienced in heightened anxious-arousal states, including increased heart rate, perspiration, tremor and increased respiration. The exact cluster of somatic-arousal symptoms that best predict PIM status is yet to be determined.

7.2 PIM, RSM and Dissociative-Anxiety Variables

As discussed in the first chapter of this thesis, visual disturbances accompanying anxiety are usually conceptualised as dissociative experiences (Steinberg, 1993). More specifically, the term derealization has been used to describe sensory distortions coupled with a subjective sense of unreality. Likewise, re-experiencing a traumatic event has also been widely described as a derealization symptom, as disturbances in the perception of time and a sense of unreality are predominant features of the experience (Papp & Gorman, 1995). This suggests that PIM (a perceptual disturbance) and RSM (a form of re-experiencing) may

be two symptomatic expressions of the same underlying dissociation construct, thus explaining the observed concordance. Based on this, it was hypothesised that dissociation would be able to significantly predict PIM and RSM cases from non PIM and non RSM cases. The results of Study 3 indicate that high levels of dissociation were more likely to be associated with RSM positive classification.

These results, however, do not support a significant predictive relationship between dissociation and PIM status. One explanation for this finding is that PIM may be related to DP/DR specifically rather than dissociation generally. Because the DES is designed to yield an overall dissociation score, it may not be specific enough to differentiate on the basis of DP/DR alone. Other facets of dissociation, such as absorption and dissociative amnesia, may not be of relevance to persons with a specific vulnerability to experience perceptual disturbances inherent in DP/DR. In comparison, RSM may relate to increases in dissociation generally, as traumatic re-experiencing is associated with perceptual, memory and absorption components of dissociation (Speigel & Cardena, 1991). An alternative explanation is that persons reporting PIM are a subset of a larger group of persons who experience a range of perceptual disturbances. That is, dissociation is not specific to PIM, but rather related to various forms of perceptual disturbances (see Castillo, 1990; Steinberg, 1993 for examples). If this were the case, it would be expected to weaken the association between PIM and dissociation, thereby accounting for the lack of significance in this study. A

larger sample may provide sufficient statistical power to detect a relationship between dissociation and PIM.

Anxious-arousal is a term used to describe somatic responses commonly associated with anxiety states. There is evidence that a somatic arousal response to a traumatic event is a significant predictor of the development of traumatic pathology (Resnick, 1997) as well as a mechanism underlying visual-perceptual disturbances (Van Diest et al., 2000). Persistent levels of heightened somatic arousal are associated with PTSD (Woodward et al., 2000), and would account for the persistent quality of PIM if this disturbance were linked to the arousal response. In addition to this, anxious-arousal is not specific to PTSD, but is experienced in a range of psychopathological conditions. This can explain why PIM occurs in psychological disorders other than PTSD. The results of this study support the link between anxious-arousal (as measured by the MASQ-AA) and PIM. However, anxious-arousal was not a significant predictor of PIM status in this sample. It is important to note that while there was no evidence to support an independent relationship between anxious-arousal and RSM, a central criterion of RSM is that the memory must elicit an anxious-arousal response (see section 1.7). This suggests that the link between RSM and PIM may be related to the somatic arousal properties of this memory symptom.

Anxiety sensitivity (AS) was postulated to relate to PIM and RSM as a potential vulnerability to experiencing these symptoms and a perpetuating factor in maintaining them. This was based on the evidence that AS is a significant factor in the reporting of sensory disturbances (Gerhard, 2002), adjustment to oscillopsia (Bronstein & Hood, 1987; Grunfeld, et al., 2000), and the vulnerability to the development of re-experiencing symptoms in PTSD (Cox et al., 1999). Indeed diagnostic groups with the highest self-reported levels of AS (e.g., PD, PTSD & Major Depressive Disorder) are the same groups that respond positively to the i-Test perceptual task (Tym et al., 2000; Cox et al., 1999). The role of AS in RSM and PIM is unclear. One explanation for the lack of a significant relationship between ASI and PIM/RSM is related to the cross-sectional design of the study. As discussed in the first chapter, the experience of persistent and intrusive recollections along with the sequale of anxiety responses is a normal reaction to a traumatic event (Noyes & Kletti, 1977). Psychopathological conditions only arise when these symptoms do not remit and interfere with daily life. As discussed by McNally (1999), there is a possibility that anxiety sensitivity may distinguish persons likely to develop posttraumatic pathology from those who adjust. As this study did not differentiate between individuals on the basis of pathology, there is a strong possibility that anxiety sensitivity only becomes a significant factor in persons with persistent rather than transient post-traumatic symptoms.

Another possible explanation for the lack of significance may be due to the broad definition of AS rather than the specific fear of cognitive dyscontrol (FCD). In relation to Hunter and colleagues' model (2003), arousal related symptoms such as dissociation are catastrophically interpreted as impending mental dyscontrol, hence perpetuating the anxious response leading to a vicious cycle. This model can help to explain the role of FCD in recurring traumatic memories, as the symptom of re-experiencing tends to be intrusive and therefore reinforces the belief that mental control is compromised. Visual disturbances such as PIM are associated with FCD because of the tendency to interpret sensory anomalies as indicators of impending loss of mental control. Further investigation of the role of FCD (rather than AS generally) in visual disturbances and traumatic memories is needed to clarify the nature of this relationship.

7.3 Mechanisms Underlying PIM

7.3.1 Pulsatile Movement

A review of potential mechanisms responsible for producing PIM (see Chapter 1) highlighted the possibility of cardiogenic movement as the cause of visual instability. This was due to the nature and form of PIM (e.g., persistent and rhythmical) and the specific vulnerability to misinterpreting cardiovascular symptoms in persons with anxiety pathology (Clark, 1986). Further ophthalmological analysis had highlighted the possibility of the pulse-wave

causing perceptual instability, and this mechanism has been an established cause of persistent aural disturbances (Sanchez et al., 1999). Based on this, it was hypothesised that PIM was related directly to cardiogenic movement (i.e., pulse wave in accordance with heart-rate). However, the data did not support the pulsatile hypothesis. The only observed effect was the aforementioned increase in PIM latency. Given these results, it is likely that PIM is related to another mechanism involved in the arousal response.

7.3.2 Ocular Movement

The mechanisms underlying illusionary movement in the perceptual literature usually involve eye-movement or retinal slip at some level (e.g., Autokinetic Phenomenon). The outflow model postulates that perceived visual movement could originate from a failure of the system to adequately monitor afferent and efferent signals. This commonly takes the form of uninitiated eye movements (e.g., nystagmus) or drifts which are responsible for illusionary movement occurring in the Autokinetic Phenomenon. According to the outflow model, illusionary movement can theoretically occur under conditions where ocular-motor signals are not matched with corresponding eye-movements. In such a scenario, eye movements are inhibited during visual fixation despite the ocular motor system generating efferent signals, resulting in illusionary movement.

The role of ocular movements in PIM requires further consideration based on observations documented in Study 3. Several participants who reported PIM also reported concurrent difficulties in maintaining steady gaze on the i-Test fixation point. In addition to this, it was observed that several participants also displayed nystagmoid like eye movement whilst perceiving PIM. These ocular movements persisted despite the experimenter's clear instructions to maintain visual fixation during testing. These observations provide bases for the investigation of eye-movements during PIM, as their role in other forms of visual instability (e.g., Autokinetic Phenomenon), have been established. It is also possible that the inability for some participants to maintain visual fixation relates to the tendency of anxious individuals to continually scan the environment for danger cues (Freeman, Garety & Phillips, 2000; Palmer, 2002,). This type of hypervigilance is especially evident in post-traumatic anxiety, and can explain why individuals with traumatic memories could display difficulties with maintaining visual fixation (Dalgleish, Moradi, Taghavi , Neshat-Doost, & Yule, 2001; Palmer 2002). The proposed link between hypervigilance, visual instability and PIM requires further opthamological and experimental investigation.

7.3.3 Arousal Mechanism

The results of Study 3 strongly implicated the role of anxious-arousal in association with PIM. As discussed in the first chapter, the arousal response has been directly linked to a range of perceptual distortions, usually as the result of hyperventilation and associated secondary mechanisms (Van Diest et al., 2000; Van Der Molen, et al., 1988; McNally, 1994). Although increasing physiological arousal via aerobic exercise did not produce a related change in visual instability, it is still likely that another arousal-related mechanism is responsible for PIM. For example, it is possible that anxious-arousal interferes with visual stability by either increasing the amplitude of ocular tremor or by decreasing the threshold to detecting existing eye movements. It is already known that arousal impacts on the function of the Vestibular Ocular Reflex, which is partly responsible for compensating for retinal slip (Furman & Jacob, 2001). Further research would need to clarify the role of anxious-arousal and ocular instability to validate this mechanism.

The other possibility is that cortical arousal may lead to perceptual instability via a central rather than peripheral mechanism (Coren, 2002). Cortical arousal has been defined as the level of central nervous system activity, and is linked to general physiological arousal (Curran, 1990; Corr et al., 1994). Increases in cortical arousal have been linked to increases in vigilance and leads to perceptual

instability (Coren, 2002), which may help to explain the mechanism underlying PIM. As cortical arousal has been linked to self-reported levels of anxious-arousal (Grandjean et al., 1977), this mechanism may explain the observed relationship between PIM and anxious-arousal. It is likely that selecting participants who meet the criteria for PTSD in a clinical sample would present with more severe symptoms, and therefore the effect size would be significantly larger than those reported in the current studies.

7.4 The Relationship Between PIM/RSM and Flicker Thresholds

Changes in cortical arousal can be indexed to flicker fusion thresholds gauged by a CFF perceptual task (Curran, 1990; Amir & Ali, 1989). Although there is clear evidence that stimulant drugs increase sensitivity to flicker (Corr et al., 1994), there is controversy in the literature over whether traumatic anxiety leads to a similar results. As discussed in Study 3, early flicker sensitivity studies on populations with traumatic anxiety yielded contradictory findings. This appears to be due to a lack of comparable definitions of anxiety between studies, and a lack of precise apparatus to measure small changes in flicker thresholds (Issacson et al., 1967).

The results of Study 3 indicated a significant positive relationship between the presence of recurrent traumatic memories and flicker thresholds. That is,

individuals with RSM tended to display higher CFF than participants without RSM. This suggests that RSM may be linked to higher levels of cortical arousal and a reduced perceptual threshold for detecting low-order visual changes. A reduction in perceptual threshold lends support to Ehlers and Clark's (2000) notion that persons with PTSD are characterised by increases in visual sensitivity. However, these findings suggest that the increased sensitivity may be more global than specifically related to stimuli present around the time of the original trauma. Irrespective of the changes in flicker thresholds, the implication that individuals with RSM have higher levels of cortical arousal provides an explanation for the observed concordance between RSM and PIM. For example, Coren's (2002) found that increased levels of cortical arousal lead to perceptual instability, which may explain the link between RSM and PIM. It is again important to note that although statistical significance between RSM and CFF was documented in the current study, the effect size was relatively small and of limited practical significance. Further investigations into traumatic memories, perceptual instability and flicker-thresholds in PTSD populations would likely lead to a stronger relationship then the effects documented in the current student-based study.

7.5 Summary and Conclusions

The general findings of these studies indicate that the base-rate of PIM and the strength of its association with RSM are comparable to earlier community based studies (Tym, et al., 2000). PIM occurs more often in participants who report RSM than participants who do not report RSM, and is most strongly associated with anxious-arousal components of this memory symptom. The trial use of self-administered questionnaires in Study 1 produced an unacceptable level of false-positive responses and did not adequately reflect the original criteria stipulated by Tym et al (2000). By reverting to an interview method of assessment based closely on the criteria for RSM and PIM used in Tym et al., (2000) clinical study, both PIM and RSM symptoms occur in approximately 16 to 18% of a student sample. The used of semi-structured questionnaires to assess PIM and RSM demonstrated high intra-rater and inter-rater reliability.

Data collected in Study 3 suggests that PIM is significantly predicted by higher levels physiological arousal states accompanying anxiety. This is evident in both the significant predictive power of anxious-arousal (i.e., MASQ-AA) in discriminating between PIM positive and PIM negative cases, and the significant predictive power of the physiological arousal component of RSM. Study 3 documented a significant relationship between dissociation and RSM. As there is an established link between anxious-arousal and dissociation, it is plausible

that the observed relationship between PIM and RSM reflects this broader relationship.

It was hypothesised that the cause of visual instability observed in PIM was directly related to pulsatile movement. The results of this study did not support this hypothesis. Increases in pulse-rate induced by aerobic exercise did not result in a corresponding increase in PIM oscillation rate. Furthermore, the resting level pulse-rate did not correlate with the resting level PIM oscillation rate, which was relatively homogeneous between participants. This suggests that another mechanism associated with arousal may underlie this visual disturbance. Such mechanisms may include tremor, movement caused by respiration or a form of nystagmus. Future ophthalmological research is required to investigate the potential role of eye-movements in the generation of PIM. An unexpected finding in this study was that aerobic exercise increased PIM latency. This effect has been documented in research on the Autokinetic Phenomenon and could implicate the Vestibular-Ocular Reflex as a mechanism underlying PIM (Singh & Singh, 1963).

Study 3 documented a significant relationship RSM and flicker sensitivity. Although there was no observed relationship between flicker thresholds and PIM, there appeared to be a significant positive relationship between anxious-arousal and flicker thresholds. This finding suggests that RSM is associated

with increased levels of cortical arousal, and the relationship between cortical-arousal and anxious-arousal may mediate the relationship between RSM and perceptual instability observed in PIM. The nature of this relationship, however, remains unclear due to issues regarding effect size and statistical power. It is likely that a larger sample derived from a clinical population would help clarify the relationship between traumatic memories and flicker thresholds.

7.6 Limitations of the Studies

7.6.1 Cross-Sectional Design

The current research employed a cross-sectional rather than a longitudinal design. The use of cross-sectional data precludes firm conclusions regarding causality or how the observed correlations change over time. As mentioned earlier, there was no data collected on the proximity of the traumatic event(s) to the time of data collection. Without this information, it is difficult to know whether PIM is associated with persistent pathological forms of intrusive memories (e.g., PTSD) or whether it occurs during normal adjustment to a traumatic event. Furthermore, the proposed maintenance role of variables such as anxiety sensitivity cannot be established without obtaining longitudinal data. However, the use of a cross-sectional design is defensible against the major aims of this study and the exploratory nature of the research.

7.6.2 Categorical Data

The key variables of interest in this study were categorical in nature, due to the fact that these symptoms are either present or absent. However, some of the criteria for assessing the presence of RSM and PIM may contain too much variation to be reduced to categorical data. For example, when participants were asked whether they experienced somatic arousal during recall of a traumatic event, the amplitude and frequency of arousal was not considered. If thresholds of arousal need to be reached before an effect is observed, the inclusion of participants with minimal and infrequent arousal in this category would lead to an increase in Type II error. Future research may need to account for this variation by independently gauging the intensity of each symptom experienced.

7.6.3 Sampling Strategy and Sample Characteristics

It is well accepted that low statistical power is associated with an increased risk of Type II error. This limitation may be particularly relevant in interpreting significance in the CFF experiment, where a larger sample would likely produce a different set of results. The difficulty in determining adequate statistical power for the current study was due to the fact that PIM and RSM have not been extensively researched in the past. It is therefore difficult to predetermine effect sizes. In light of this, it was justifiable to use a sample size similar to that of the Tym et al., (2000) community based study. However, future research may take into consideration issues concerning statistical power and effect sizes.

It is well accepted that randomised sample selection in experimental studies eradicate many of the known threats to internal and external validity. This study used a convenience rather than random sample selection, which increases the chance of erroneous findings and limits the generalisability of the results. However, as mentioned in section 2.0.1, the use of convenience sampling is acceptable under circumstances where little is known about the subject area (Burns, 1997). As PIM is an anomalous symptom, the use of convenience sampling in this exploratory study is justifiable. It is important to note for future research that a randomised approach to subject selection from the population would yield more generalisable findings.

The collection of additional information on bio-hehavioural characteristics of the sample would be a useful strategy for future research in this area. For example, it is not known whether participants in these studies have a history of psychopathology, medical illness (not directly related to cardiovascular or visual functioning), psychotropic drug use or other predisposing factors related to anxiety. Future research could focus on collecting these data in order to adequately assess the impact of bio-behavioural factors on the occurrence of both PIM and RSM.

7.6.4 Specificity of Instruments

A link between DR and visual disturbances has been established in the literature and formed the rationale for investigating whether PIM was associated with dissociation (Steinberg, 1993). Likewise, the relationship between the fear of cognitive dyscontrol and re-experiencing has also been documented in the literature (Cox et al., 1999). However, this study employed measures for dissociation (i.e., Dissociative Experiences Scale) and anxiety sensitivity (i.e., Anxiety Sensitivity Index), which yielded scores indicating the general level of these constructs. The aggregate scores from these scales may not have been specific enough to gauge differences in the specific sub-domains of FCD and DR. The total number of participants in the current study was not sufficient for factor analytic reduction of the DES into its component parts. Future research could utilise measures that have more specificity to the constructs being tested. For example, the use of the Anxiety Sensitivity Index (Revised) with expanded items for AS sub-factors would be useful for future research into FCD and PIM, RSM relationship.

7.6.5 Voluntary Recall of Traumatic Memories

Tym et al. (2000) originally defined RSM as a vivid memory of a fearful event. Classification of RSM in the Tym et al. study was based on participants' voluntary recall of a traumatic memory, during which time the core features of RSM were assessed. However, this definition of RSM may be too restricted to

account for extreme cases of re-experiencing in PTSD. As mentioned in section 1.7.1, traumatic memories in PTSD are characterised by vivid involuntary recall and vague intentional recall. Therefore, asking the participants to voluntarily recall a traumatic event of great vividness would likely result in a negative classification for individuals with PTSD (i.e., an increase in Type II error). As this current study was concerned with addressing inconsistencies in the operational definition of RSM, the original stipulated criteria for this memory symptom was closely adhered to. The use of PTSD specific criteria was viewed as a possible source of error and would limit the comparability of the results to earlier studies. It would be useful to assess whether RSM that can be voluntarily recalled differ from those that are involuntarily recalled. Future research on this topic should take into account the various modalities of traumatic memory recall to reduce erroneous classification from this source. A possible way to reduce such a problem would be to investigate the occurrence of PIM in individuals that have been independently diagnosed with PTSD. This strategy is based on the assumption that every person with PTSD would automatically meet the criteria for RSM. By utilising the standardised protocol to assess PIM (outlined in the Chapter 2) with individuals that have been independently diagnosed with PTSD, the risk of experimenter bias would also be reduced.

7.6.6 Unaccounted Mediating and Extraneous Variables

At this stage of early experimental research, it is likely a number of important variables related to PIM and accounting for its relationship to RSM were not considered in this study. For example, individual characteristics such as neuroticism, paranoia, fantasy proneness and introversion/extraversion have shown to relate significantly to the nature and form of the Autokinetic Phenomenon (Toch, 1962; Royce et al., 1966; Wallace & Garrett, 1973). These factors could mediate the observed relationship between RSM and PIM, and help uncover the mechanisms responsible for producing persistent illusionary movement. Likewise, environmental conditions, fatigue exposure to drugs and alcohol are all factors that were not tested in this current study, but could have a link to PIM and impact on memory recall of a traumatic event. What is clearly understood is that PIM does not appear to be a perceptual artefact of movement caused by the pulse-wave. Ruling out the pulse-wave as an underlying mechanism allows future research to be directed toward other possible hypotheses to account for PIM and its relationship to RSM.

7.6.7 Statistical Versus Practical Significance

The association between PIM and RSM is of statistical significance, but the concordance rate of approximately 50% does not support the use of the i-Test as a screening device for traumatic memories. While the rate of PIM positive participants reporting RSM is much higher than PIM negative participants, the

usefulness of PIM as a marker for RSM is limited. The reported concordance in Tym et al. (2000) clinical study was high enough to suggest that PIM could be a clinically useful marker for the presence of treatable post-traumatic stress symptoms. The findings of this research combined with the results from the Tym et al (2000) community based study does not support the usefulness of the i-Test as a screening device for traumatic memories outside a clinical sample. Likewise, the statistical significance between CFF and RSM (as discussed in section 6.6.4) is of limited practical significance due to the relatively small effect sizes.

Although the clinical usefulness of the i-Test is questionable, the consistent and reliable nature of PIM does raise important questions on the nature of this visual symptom and its relationship to anxiety pathology. At the very least, the i-Test provides a means for eliciting a specific visual disturbance that is both reliable and consistent in form (i.e., very similar oscillation rate between individuals and in the same individuals over time). This can be useful for future research into visual disturbances, as there are few methods for inducing such symptoms for experimental research. Despite the questionable utility of the i-Test, an understanding of the mechanisms underlying PIM could have implications for understanding perceptual symptoms and their role in traumatic anxiety reactions.

7.7 Proposed Link Between Traumatic Memories and Dissociative Anxiety

The results documented in this thesis suggest that traumatic memories, as defined in RSM, are associated with elevations in self-reported dissociation, whereas PIM is associated with increased levels of anxious-arousal. Given the breadth of literature establishing the links between traumatic re-experiencing and dissociative-anxiety symptoms, the observed increases in these symptom clusters were expected. There is, however, a lack of an explanation for the higher rates of visual disturbances in persons with traumatic memory symptoms. The following model can be used to explain the relationship between visual disturbances related to arousal and traumatic re-experiencing based on the findings of this research and those documented in the general literature.

In the literature, it is commonly understood that perceptual distortions are a central component of DR (Steinberg, 1993). Researchers have documented high levels of self-reported DR during a traumatic event, specifically in individuals that later develop PTSD (Ehlers et al., 1998; Murray et al., 2002). A subset of persons with PD also experience perceptual disturbances during panic (McNally, 1999). These individuals tend to exhibit high levels of agoraphobic avoidance, a behavioural strategy similarly displayed by those with PTSD (American Psychiatric Association, 1994). This establishes that in extreme states of anxiety (e.g., panic and traumatic re-experiencing), perceptual disturbances are commonly reported.

Cognitive theorists have postulated that traumatic re-experiencing is most easily elicited by visual perceptual cues that resemble those occurring around the time of the traumatic event (Ehlers & Clark, 2000). Due to the high base-rate of DR during a traumatic event, it is plausible that visual-sensory disturbances may form triggers for subsequent re-experiencing episodes. Through this process, visual anomalies become associated with high levels of anxiety experienced at the time of the traumatic event. As persons with PTSD display high levels of baseline anxious-arousal (Woodward et al., 2002), and heightened levels of arousal are directly linked to visual disturbances (Taylor, 2000), it seems plausible that these individuals will experience such disturbances more often than others. The catastrophic interpretation of visual anomalies as potential warning signals of impending re-experiencing acts to maintain the cycle. As a result, visual disturbances may act as a perpetuating factor in PTSD. This proposed relationship is consistent with the model proposed by Hunter et al. (2003) in relation to the perpetuation of dissociative symptom in depersonalisation disorder.

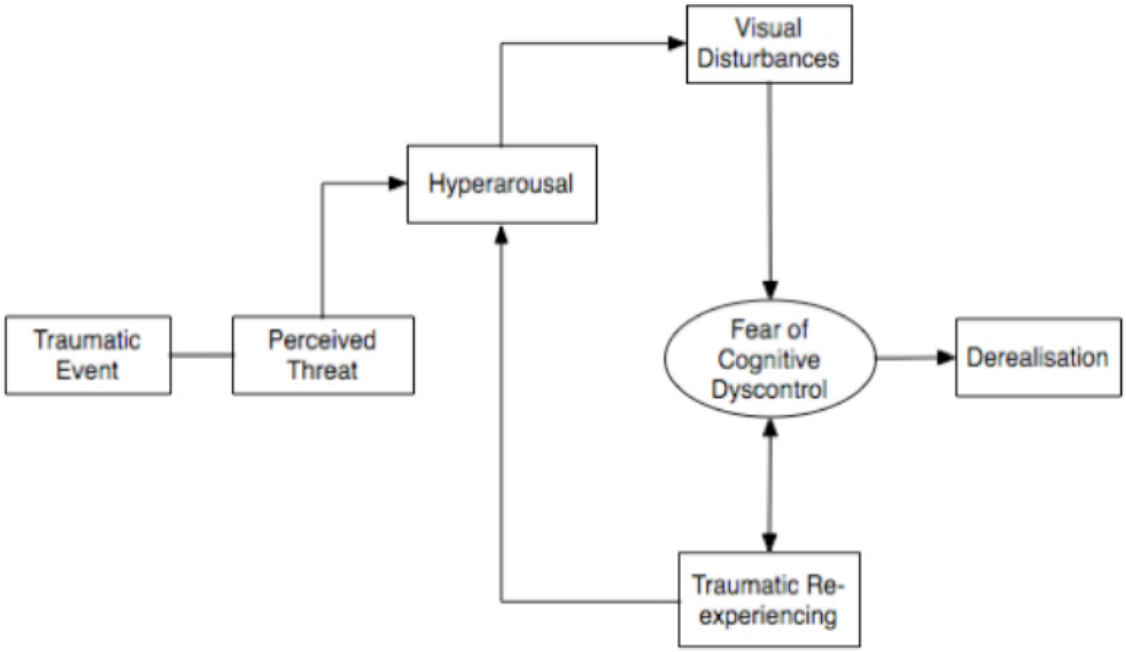

Figure 3. Proposed Model Linking Visual Disturbances with Traumatic Re-experiencing.

In the proposed model, an event which is interpreted as threatening would likely lead to an anxious-arousal response. As already explained, such a response can result in a range of visual-sensory disturbances. These disturbances through paired association become salient triggers for further re-experiencing episodes. The fear of cognitive dyscontrol is likely to perpetuate the cycle, as it leads to catastrophic interpretation of anomalous visual symptoms as well as the vulnerability to experience intrusive recollections of the traumatic event. According to the proposed model, dissociation in the form of DP/DR is merely an interpretation of the anomalous sensory distortions that arise from heightened arousal and is mediated through a fear of cognitive dyscontrol. For example, an experience of seeing stationary objects move may be interpreted as DR, as it

conflicts with expectations regarding properties of objects in the external environment. Persons who fear the loss of mental control are more likely to catastrophically interpret these visual symptoms as an indicator of impending insanity. This is likely to trigger traumatic memories as re-experiencing episodes reinforce the belief than mental control has been compromised.

Illusionary visual phenomena, such as the Autokinetic Effect, may be useful in assessing the validity of the proposed model. This is due to the fact that illusionary phenomena are difficult to attribute to external causes. A lack of an available explanation leaves the individual with a tendency to question the reliability of his/her perceptions, thus tapping potential vulnerability for the fear of cognitive dyscontrol.

7.8 Implications and Directions for Future Research

The current research implicated the role of eye-movements in persons with PIM. However, these data were limited to observations and participants' self reported difficulties in maintaining fixation. Further ophthalmological research is required to adequately investigate the role of eye-movements in PIM. As the current research suggested that anxious-arousal is significantly related to PIM, an investigation of eye movements would be likely to shed light on whether arousal or another component of RSM leads to ocular instability. This information would be required to firmly rule out eye movements as a causal mechanism.

Another possible explanation that remains to be tested is that PIM is a form of the Autokinetic Phenomenon (AP). As mentioned in the first chapter, AP and PIM share many characteristics, including methods for eliciting the illusionary movement and correlates with psychopathology (Rock, 1997; Borresen, 1982). AP has been studied for many years, and the role of retinal slip in producing the illusionary movement is well established (Leibowitz, Shupert, Post, & Dichgans, 1983; Pola & Martin, 1977; Hoyenga & Benjamin, 1978). Future research can investigate whether individuals with PIM experience the same illusionary movement in standard AP paradigms. If both PIM and AP do converge, it would be feasible to suggest that PIM is due to eye-movements.

A promising finding in this research was that traumatic memories are related to increased flicker sensitivity. Such a finding may help explain the differential responses to flicker amongst persons displaying agoraphobic avoidance (Wilkins, 1995). In addition to this, a change in flicker thresholds indicates that anxious-arousal response impacts on low-order visual functioning. The positive relationship between RSM and CFF suggested that the notion of cortical arousal plays a mediatory role between traumatic memories and visual instability. Further research with a larger sample is required to validate these findings, and investigate the relationship between flicker thresholds and anxiety pathology in more detail.

Recent research on the taxonic structure of Anxiety Sensitivity in PTSD and panic disorder has suggested that there may be common cognitive diathesis for these two conditions (Berstein et al., 2005). Further research on the taxonic structure of Anxiety Sensitivity in relation to the development of PIM and RSM is likely to uncover whether specific sensitivities are predictive of these symptoms. This will address the limitations of the current dimensional approach to the measurement of AS in the current studies as well as provide useful information on which aspects of AS are most closely associated with this sensory disturbance.

These research findings hold both theoretical and practical significance in understanding post-traumatic anxiety. In particular, this research highlights the role of visual disturbances in the generation and maintenance of trauma related pathology. As research into somatic symptoms in Panic Disorder has yielded the development of effective treatments, understanding the nature of visual symptoms in PTSD may also lead to similar advances. For example, exposure to anomalous visual phenomena (e.g., Autokinetic Phenomenon) whilst simultaneously challenging negative automatic thoughts (e.g., relating to the fear of cognitive dyscontrol) may be an effective treatment for trauma related disorders. This approach may be effective for other forms of psychopathology characterised by the same underlying anxiety sensitivity. Future research would

need to establish whether persons with PTSD display a differential response to perceptual tasks involving illusionary visual phenomena prior to the development of treatment protocols. The proposed model can form the initial foundations for further research on the topic of visual disturbances and traumatic anxiety.

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