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Affective responses to imaged motor fluency

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Affective Responses to Imaged Motor Fluency

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This thesis is submitted to the School of Sport Health and Exercise Sciences, Bangor University in fulfilment of the degree of Doctor of Philosophy.

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ABSTRACT

Affective judgements of objects can be influenced by motor fluency (Hayes et al, 2008). However, the mechanisms that link emotion to motor fluency are not well understood. This thesis investigates whether imaging actions evokes an emotional response to fluency. In Study 2.1, participants imaged moving objects fluently (no obstacle) or non-fluently (avoiding an obstacle). Results indicated higher liking ratings for objects of fluent actions. Moreover, higher kinaesthetic imagery ability was associated with stronger emotional responses to fluency condition (Study 2.2). In Study 3, participants completed the movement imagery task from Study 2.1 using one of three imagery conditions: internal visual imagery, kinaesthetic imagery, or a combination of the two. Liking ratings were higher for objects of fluent actions, but only for the groups that used kinaesthetic imagery. Study 4 tests whether imaged motor fluency evokes emotion if the task does not require attending to emotional states. A direct measure of affect was implemented by measuring affective facial expressions using electromyography (EMG). This direct measure revealed that participants smiled more when responding to objects that were presented in the fluent condition compared to the non-fluent condition, suggesting emotional response to fluency is more positive and less negative than to non-fluency. This muscle-by-fluency interaction was evident while planning the imagery.

These Studies demonstrate the possible embodied nature of emotional responses to movement fluency via kinaesthetic imagery, and that responses to imaged motor fluency occur spontaneously, even when attention is not directed toward emotional states.

Chapter 1

General Introduction

Individuals interact with people and objects every day, resulting in a host of emotional responses. These responses are fundamental experiences and one of the core responses to a stimulus. According to the appraisal theory of emotion, emotional responses occur at a number of levels. At a basic level individuals must make a valence judgement regarding the stimuli (see Ellsworth& Scherer, 2003 for explanation of appraisal process in emotion). Valence is a term used by emotion theorists referring "to the 'positive' and 'negative' character of an emotion and/or of its aspects (such as behaviour, affect, evaluation, faces, adaptive value, etc.)" (Colombetti, 2005, p.103). This is to say that individuals must decide if the stimulus item is essentially good or bad (valence or intrinsic pleasantness; Ellsworth & Scherer, 2003).

On the decision of the valence/intrinsic pleasantness of the stimulus (i.e. good or bad), this may then in turn engage the appropriate action response(s), according to the premise that emotions are a determining factor in actions (Döring, 2003). This is highlighted by the definition of emotion put forward by Arnold (1960) as "the felt tendency toward anything intuitively appraised as good (beneficial), or away from anything intuitively appraised as bad (harmful). This attraction or aversion is accompanied by a pattern of physiological changes organised toward approach or withdrawal. The patterns differ for different emotions" (p. 182).

The question then arises about the driving force behind individuals' judgements of valence, that is, for likeability or pleasantness of an item. To date, most investigations into individuals' preferences have examined how aspects of the object (e.g. colour, shape, texture) influence preference. However, some researchers have asserted that the dynamics of perceiving an object (e.g. Winkielman & Cacioppo, 2001) and interacting with an object (Hayes, Paul, Beuger & Tipper, 2008) also influence affective responses to the object. Specifically, it has been demonstrated that when objects are perceived or interacted with more fluently, emotional responses towards that object are more positive than when the perception or interaction is less fluent.

This thesis will extend these findings to the domain of imagery. That is, it will investigate whether the affective response evoked by an *imaged* action will be more positive when the action imaged is a fluent action compared to a non-fluent action. To establish a rationale for this investigation, two research areas, fluency and imagery, will be reviewed with a focus on how each of these topics relates to affect.

Perceptual fluency and affect

Previous research has demonstrated that fast, fluent visual processing of a stimulus results in greater liking of the stimulus (e.g. Berlyne, 1974; Jacoby & Dallas, 1981; Whittlesea, 1993). These studies supported the concept of perceptual fluency. “Perceptual fluency ... is defined as the facilitation of task performance due to prior experience with a stimulus, without the subject necessarily being aware of prior exposure to the stimulus” (Nessler, Mecklinger, Penney, 2005, p. 266). Much of this area of research has been grounded in the mere exposure effect (Zajonc, 1968). The mere exposure effect is a phenomenon in which rating of a stimulus object is more favourable as a result of repeated exposure to the stimulus (Willems & Van der Linden, 2006). Previous investigation has indicated that people will have a tendency to prefer stimuli that they have been exposed to before and that this fluency is apparent from the faster reaction times in the identification of the stimulus (see Harrison, 1977 and Bornstein, 1989, for reviews). It has been proposed that as a result of this prior exposure, the fluency of processing is increased, and our emotion systems are sensitive to fluency of processing.

To test this idea Reber, Winkielman, and Schwartz (1998) manipulated fluency in a variety of ways other than repeated exposure, and found that perceptual fluency did increase liking. The authors employed three different manipulations. Experiment one employed the use of matching and non-matching primes before showing a target picture. This achieved higher perceptual fluency and the participants judged stimuli as prettier if the targets were preceded by a matching rather than a non-matching prime. Experiment two manipulated perceptual fluency by use of figure-ground contrast (participants rated the prettiness of circles on a background of varying degrees of contrast). Stimuli were judged as more pretty, and less ugly, the higher the contrast. In experiment three, perceptual fluency was manipulated by presentation duration (durations of 100, 200, 300, and 400 ms). Stimuli shown for longer duration were liked more, and disliked less. The authors concluded that (1) perceptual fluency increases liking, and (2) the experience of fluency is affectively positive as reflected in the results by a decrease in the judgements of ugliness and disliking of the stimuli and an increase in the judgements of prettiness and liking of stimuli.

However, a criticism of the work by Reber et al. (1998) is that affective responses were measured using an explicit question, such as "*How pretty was the picture?"* The participants' responses may not have been the result of increased affect and may merely be the result of misinterpretation of the fluency signal resulting from the stimulus processing dynamics. According to Reber et al. (1998), the experience of affect in their studies is as a direct result of the experience of high fluency. However, there are several models that could account for these findings without any reference to the affect system. There are three models (reviewed by Winkielman & Cacioppo, 2001) that assume the conversion from fluency to affect is as the result of so called 'two-step' models that hold that fluency is affectively neutral, and dependent on the judgement task can lead to increases in both positive and negative responses (Winkielman, Schwarz, Fazenderio, & Reber, 2003).

According to the non-specific activation model, processing manipulations do not elicit affective responses. They merely "produce the greater accessibility of the activated representation" (Mandler, Nakamura, & Van Zandt, 1987, p. 646). The model also assumes that processing manipulations can influence any judgement made about the stimulus, including judgements of liking and disliking. So fluent processing results in greater neural activation and this can be converted into any required evaluative response. There is no direct affect experience evoked by fluency. Perceptual fluency findings would be as a result of fluent stimuli causing greater neural activation and being rated higher compared with non-fluent low neural activation stimuli. According to the fluency attribution model, processing manipulations lead to an affectively neutral experience (Bornstein & D'Agostino, 1994; Jacoby, Kelley, & Dywan, 1989; Seamon, Brody, & Kauff, 1983), although in this model processing facilitation enhances judgement as the participants are trying to arrive at the most economical and reasonable explanation. As with the non-specific activation model, this model allows for conversion into any evaluative context. Finally, the familiarity attribution model assumes that processing manipulations results in a vague feeling of familiarity. This familiarity can be misattributed to affect when participants are asked to rate the stimulus (Bonnano & Stillings, 1986).

An alternative to these two-step models is the hedonic fluency model. Winkielman and Cacioppo (2001) make two predictions based on this model that contrast with the two-step models; (1) processing facilitation elicits a genuine affective response and (2) affective reaction is hedonically positive (increased perceptual fluency results in increased liking and decreased disliking). The authors addressed the ambiguities in the findings of Reber et al. (1998) to ascertain whether increased evaluative ratings that participants report were as a direct result of the experience of high fluency, or through a two-step conversion similar to the above models. Winkielman & Cacioppo (2001) measured affective responses to fluency using facial electromyography (fEMG), as this was based on the observations that affective responses are reflected in the electrical activity of facial muscles (Cacioppo, Petty, Losch, & Kim, 1986;

Lang, Greenwald, Bradley, & Hamm, 1993). More specifically, positive affective responses increase muscle activity over the zygomaticus major muscle (ZM; involved in smiling) and negative affect increased muscle activity over the corrugator supercilii (CS; involved in frowning). Winkielman and Cacioppo asked participants to view stimulus pictures of everyday items (e.g. horse, airplane, house, dog). Fluency was manipulated through visual priming in study 1 and variations in presentation time in study 2. fEMG recordings were taken while the participants viewed the stimulus, and 6 seconds after the stimulus presentation the participants were then asked to rate the items. Results indicated that there was higher activity over the ZM for easier to process stimuli, indicative of positive affect. However, results did not indicate an effect for CS, so participants did not experience negative affect during the low fluency conditions, thus suggesting (and supporting the work by Reber et al., 1998) that fluency evokes positive affect. Further, difference in activity occurred several seconds before the participants were to make evaluative judgements regarding the stimulus, indicating a spontaneous affective response to processing fluency.

Taken together, the findings of Winkielman and Cacioppo (2001) and Reber et al. (1998) suggest that manipulations of processing fluency have a genuine affective response (supporting the hedonic fluency model that fluency is hedonically marked and triggers the affect system) and further that the affective response is positive (arguing against two-step models that fluency can elicit positive and negative responses).

Motor fluency and affect

One of the functions of the brain is for representing the world in terms of actions that an organism must produce to survive. The sensory system evolved to facilitate action (Gibson, 1979), so the visual system assesses how we can physically interact with the environment around us. Therefore it is natural to extend the notion of perceptual fluency into motor fluency (the nature of motor fluency will be discussed in a subsequent section but for now we refer to motor fluency as actions that are facilitated or perceived in some way to be facilitated). For example, Tucker and Ellis (1998) demonstrated that despite there being no intention on the part of participants to act, merely viewing items that may be acted upon can automatically activate the motor responses. The investigators showed participants pictures of objects and asked them to judge whether they were depicted as right way up or inverted (by means of a right or left-hand key press). The pictures were also presented in such a way as to be optimal for right-hand or left-hand grasps (e.g. a sauce pan with the handle oriented to the right side to facilitate a right-hand grasp). Despite the fact that the participants were not acting on the object, results indicated that key press responses were faster when the hand that was used for the key press was matched with the hand afforded by the object in the image. This result indicated that viewing a graspable object automatically increases the likelihood of mental simulation of the action afforded by the object. This provides evidence that we may represent our surroundings as opportunities for action.

It is expected that the actions that are represented when viewing a scene, or executed when interacting with objects are of significance to the actor. Therefore it can be predicted that actions, or simulations of actions, should generate affective evaluations. Recently researchers have begun to look at how the motor system can drive preference and valence judgements about stimuli (e.g. Beilock & Holt, 2007; Van den Bergh, Vrana, & Eelen, 1990). Hayes, et al. (2008) tested the influence of motor fluency on affect. More specifically, they tested whether the quality of motor interactions with objects influence affective responses, that is how we feel about the object. Participants were seated at a table with an ordinary everyday household item placed in front of them. The action was simply to reach out and grasp the item and as quickly as possible move it to a destination mat that was placed several inches away. The movements made were either in a fluent or a non-fluent manner. This fluency manipulation was achieved through the use of a vase filled with water. For fluent conditions the vase stood to the left of the destination mat, thus in no way impeding the movement. For non-fluent conditions, the vase stood to the right of the mat so acting as an obstacle in the action path. The authors manipulated fluency in this way as they felt “it would likely disrupt action on a number of dimensions; the non-fluent actions were executed more slowly, required a longer and more complex trajectory and were more effortful to execute” (Hayes & Tipper, 2012, p. 5). The results of Hayes et al., (2008) indicated that the affective liking ratings were influenced by the action fluency. Items that were the object of fluent movements were rated significantly higher than those that were the object of non-fluent movements. Conclusions drawn from the study were that positive affect is evoked from fluent interactions with objects.

However, the authors noted that in generalising their findings to everyday encounters there was one notable difference between the experimental conditions and everyday situations. This was that in an everyday situation the assessment of our feelings about the objects that we interact with are not required to be explicit. In fact, the feelings that arise may often guide out interactions with our surroundings in a more implicit manner and often outside our awareness (Hayes & Tipper, 2012).

Cannon, Hayes, and Tipper (2010) addressed this issue by investigating whether affect associated with motor fluency arises spontaneously when emotional responses to the objects of interaction are not consciously attended to. Cannon et al. used fEMG to record facial muscle activity across the ZM and the CS sites to measure affective responses to implicit motor activities in a categorisation task. They tested whether positive affect associated with motor fluency arises spontaneously when feelings about the objects of the interactions are not consciously attended to. Participants viewed images of items and indicated via key press whether the items were kitchen or garage items. All items were graspable items and in half the trials the handle in the image was orientated to the hand that corresponded to the correct key press. Stimuli were also presented laterally on the computer monitor. In the grasp-compatible condition (handle oriented toward the hand of the correct key press), the stimulus was also presented on the side of the screen corresponding to the correct key press. In the grasp-incompatible condition, the stimulus appeared on the side opposite to the correct key press. Hence response compatibility was determined by spatial stimulus-response compatibility (i.e. the Simon effect; Simon & Small, 1969), as well as grasp affordance. Results indicated that items in the compatible condition resulted in faster key press and more activity in the ZM indicating a positive affective response to motor fluency, even when participants were not attending to their emotions. Thus motor fluency evokes positive affect even when not attending to feelings about the situation as is the case in daily life.

Motor fluency

So far motor fluency has simply been referred to as actions that are facilitated or perceived in some way to be facilitated. But what exactly constitutes motor fluency? As pointed out by Hayes et al. (2008), although motor fluency is analogous to perceptual fluency in that it is a relatively facilitated motor processing of a stimulus, unlike perceptual fluency motor fluency cannot be measured by reaction time alone. Although facilitated processing may indeed produce faster actions, in some situations facilitated actions may be actions that are not faster, but are less spatially or temporally variable. Or facilitated actions might be kinematically equivalent to non-facilitated actions but experienced as less effortful. Therefore, as suggested by the authors, a number of factors need to be considered as possible measures of motor fluency; these may include (but are not limited to) factor such as speed and variability of action planning and action execution, and perceived effort associated with action.

Within this thesis, the participants will image moving items, either in the absence (fluent motor action) or presence (non-fluent motor action) of an obstacle. Moving an object around an obstacle influences a number of aspects of motor fluency, including complexity of the movement path (fluent actions have shorter and simpler hand trajectory), and feelings of effort.

Perception of effort is an important mechanism for regulating energy expenditure. Indeed, when Beilock and colleagues (e.g. Ping, Dhillion, & Beilock, 2009; Yang, Gallo, & Beilock, 2009) suggested that participants may prefer actions that are easier, this may have included the idea that the preference was on the basis of less energy expenditure or a lower perceived level of effort to interact with the object.

Motor fluency results in positive affect in a non-acting body

Within the literature, embodied cognitive perspective has emphasised the functional links between perception and action. This is that performing and perceiving actions draw on some of the same underlying cognitive and neural representations (Prinz, 1997; Ping et al., 2009). Evidence suggests that our surroundings are represented via covert motor simulation of how actions associated with encountered objects may be executed (e.g. Ellis & Tucker, 2000). Therefore, if observing an item results in covert motor simulation of an action with that item, then this simulation may give rise to information about how easy or difficult interaction with this object may be. If individuals have a preference for interactions that are easier (or more fluent), then it follows that preference may be driven by the motor system (Ping et al., 2009; Yang et al., 2009) even when the individual is not acting.

Drawing on the result of Tucker and Ellis (1998), Ping et al., (2009) conducted a similar study where the authors examined whether preferences for objects can be driven by how easy it is to act on them. Participants were presented with two items (one in an easy to grasp condition and the other in a hard to grasp condition) and asked to move their preferred item to another spatial location. Results indicated a preference for the item that was comparatively easy to grasp (i.e. handle pointed towards the participant rather than away), thus providing further evidence of the impact the non-acting motor system has on preferences about stimuli. As such, if individuals have a tendency to want to complete easier or more fluent actions, and information, from mental simulation, can be derived about how easy or difficult interactions with an item may be, then it follows that preference for one item over another may be driven by the motor system (Ping et al., 2009).

One reason for why this non-acting body may result in the preference being the same as an acting body could be due to a link between perception and action. That is the performance of an action and the perception of an action share common cognitive and neural representations (Prinz, 1997). One way that this link has been investigated to through the use of mental imagery tasks.

Imagery

Imagery is described as an experience that mimics real experience, and involves using a combination of different sensory modalities. White and Hardy (1998) stated that "we can be aware of 'seeing' an image, feeling movements as an image, or experiencing an image of smell, taste or sounds without experiencing the real thing" (p.389). Moran (2004) defined imagery as "perception without sensation" (p. 133). Within these definitions is the notion that individuals are self-aware and conscious during the imagery experience (Richardson, 1969).

For example, White and Hardy distinguish imagery from dreaming because the individual is awake and conscious.

These definitions of imagery highlight the fact that imagery is a sensory experience in which the real world can be represented using combinations of different sensory modalities (Callow & Hardy, 2005). The simulation process of imagery gives rise to subjective experience of perception. Given that different types of perception give rise to correspondingly different forms of imagery (Moulton & Kosslyn, 2009), various types of imagery processes have been identified. One of these processes that has attracted research interest is motor imagery. Motor imagery is defined as "mental simulation of a specific action without any corresponding motor output, and shares similar mechanisms underlying movement preparation and execution" (Guillot, Lebon, Rouffet, Champely, Doyon, & Collet, 2007). Typically, motor imagery or the "covert simulation of movement" (Holmes, 2007, p. 1) is evident whenever people imagine actions without engaging in the actual physical movements involved. However before considering the importance of motor imagery in relation to this thesis, a question of terminology with regards to motor imagery needs to be addressed.

Within the research literature there is some confusion as to whether this construct should be referred to as 'motor imagery', 'kinaesthetic imagery', or 'movement imagery'. Some researchers regard 'motor imagery' as being synonymous with 'movement imagery' (e.g. Roberts, Callow, Hardy, Markland, & Bringer, 2008) or 'imagery of movement' (e.g. Isaac, Marks, & Russell, 1986), whereas other researchers favour the term 'kinaesthetic imagery' (e.g. Proske & Gandevia, 2009). For example, Moulton and Kosslyn (2009) suggested that motor imagery is "proprioceptive or kinaesthetic imagery – one experiences the bodily sensations of movement, not the movement commands themselves" (p. 1273). In an attempt to clarify this matter for the purpose of this thesis, the conventional term 'motor imagery' shall be retained, due to the fact that research suggests that it is possible to form a motor image of ones static position (e.g. in an isometric contraction [muscle fires but there is no movement at the joint]) without the rehearsal of a dynamic movement of the body (Hashimoto, Ushiba, Kimura, Liu, & Tomita, 2010). In other words motor imagery involves the absence of overt motor output rather than of overt movement itself. Inspection of the relevant research literature has highlighted that as apart from the terminology confusion, there are also significant conceptual confusions as well.

Mahoney and Avener (1977) seem to be the first researchers to distinguish between internal and external imagery perspectives, describing external imagery as when "a person views himself from the perspective of an external observer," and internal imagery as when there is "an approximation of the real-life phenomenology such that a person actually imagines being inside his/her body and experiencing those sensations which might be expected in the actual situation" (p. 137). One aspect of contention surrounding the conceptualisation of imagery perspectives is the confound in the definition of internal imagery put forward by Mahoney and Avener (1977). Internal imagery could involve visual imagery from an internal perspective (i.e. looking through your own eyes), kinaesthetic perspective (i.e. the feeling and movements associated with the action), or a combination of the two (cf. Cumming & Ste-Marie, 2001; Holmes, 2007; White & Hardy, 1995). As a result when manipulating internal imagery (using the Mahoney and Avener definition of the construct), participants could be imagining from an internal visual or kinaesthetic modality, or a combination of the two, consequently threatening internal validity and resulting in inconsistencies in the research literature. In fact within the research literature (e.g. Hardy, 1997; Moran, 2009), this confound is regarded as one of the reasons for inconsistencies in the research exploring the effects of imagery on motor performance.

A number of researchers regard motor imagery as being synonymous with only one of two visual imagery perspectives – that is imagery from the first person perspective, or the internal imagery (first person perspective) of sports psychologists (Decety, 1996). Jeannerod (1997) endorsed this idea by distinguishing between “visual or third person perspective imagery and motor imagery, which is experienced from within, as the result of a first person process, where the self feels like an actor rather than a spectator” (p. 95). However, this has been challenged by research in cognitive sport psychology. Morris, Spittle, and Watt (2005) pointed out that imagery perspective (internal or external) refers to whether an image is experienced from inside or outside one’s body and does not designate a particular modality (visual or kinaesthetic). In other words, “kinaesthetic and internal imagery are not the same and visual and external imagery are not the same” (p. 132). Fourkas, Avenanti, Urgesi, and Aglioti (2006) also pointed out that motor images can be formed using either the first-person or the third-person perspective. This idea that motor imagery representations can be accessed consciously using the third-person perspective is supported by evidence from qualitative studies (Moran & MacIntyre, 1998), descriptive research (Callow & Hardy, 2004; Callow & Roberts, 2010) and experiments (Hardy & Callow, 1999) in sport psychology. For example, in a task involving form based movement, external (third person) visual imagery perspective was superior to internal (first person) visual imagery perspective in the facilitation of motor performance (Hardy & Callow, 1999), and further to this that kinaesthetic imagery may have a stronger relationship with an external perspective than with an internal one (Callow & Hardy, 2004). These results provide evidence that internal imagery and kinaesthetic imagery are not synonymous and that they refer to different aspects of imagery.

Based on the above findings, in relation to this thesis, imagery will be distinguished as follows: the thesis will distinguish between the imagination of movement per se and kinaesthetic imagery. The imagination of movement may be undertaken using one of the two visual imagery perspectives (internal visual imagery or external visual imagery), whereas kinaesthetic imagery will refer to the ability to mentally simulate physical movement including the force and effort involved in movement and balance, and spatial location (Callow & Waters, 2005).

Further to avoid any confusion between imagery perspectives (internal visual imagery and external visual imagery) and the modalities (visual imagery and kinaesthetic imagery), imagery was explained to the participants as follows; internal visual imagery (IVI) is imaging from an internal point of view as if looking through your own eyes, external visual imagery (EVI) is imaging from an external point of view as if watching yourself from an outside perspective, and kinaesthetic imagery (KIN) is the feeling of performing the movement. It was explained precisely what movements were to be imaged, the form of imagery to be used (if specific for the task), and whether the participants needed to combine any of the perspectives or modalities.

Shared processes in motor imagery and motor actions

This thesis aims to investigate whether motor imagery evokes affective responses to motor fluency in the same way that performed actions do. This research proposal is based on several lines of research that have noted a close relationship between mental or cognitive representations of action (including imagery) and the processes that underpin overtly performed actions. The understanding of motor cognitive processes such as movement planning and mental rehearsal has been helped by motor imagery research (Caeyenberghs, Wilson, van Roon, Swinnen, & Smith-Engelsman, 2009), as have the investigations into whether or how action performance of a particular action can be affected by conscious thoughts (Baumeister, Masicampo, & Vohs, 2011). Motor imagery research has also aided in the exploration of embodied cognition (the idea that cognitive representations are grounded in and simulated through sensorimotor activity; Slepian, Weisbuch, Rule, & Ambady, 2011), or that mental processes that evolved to control action can also be used off-line to simulate motor skills and knowledge (Wilson, 2002). For example, Lorey et al. (2009) proposed that "body related experiences also shape processes such as perception or imagery that were formally conceptualized as purely cognitive" (p. 233).

Extensive research in sports science has revealed that practicing skills via motor imagery can improve performance (Orlick & Partington, 1988; Vealey, 1994). So why does imagery work? Imagery shares some of the same neural pathways and mechanisms with like-modality perception (Farah, 1984; Kosslyn, 1994) and also with the preparation and production of movements (Decety & Ingvar, 1990; Jeannerod, 2001). That is there are close parallels between perceiving, imagining, and motor control (planning and executing actions). The recognition of these parallels led to the functional equivalence hypothesis (e.g., Finke, 1979; Jeannerod, 1994).

The notion of functional equivalence hypothesis is that while imaging motor actions, the neural motor network is activated, but is inhibited at a certain stage to prevent overt physical movement (Jeannerod 2001). Several neuroimaging techniques have been used to investigate this overlap in activated brain areas (see Grèzes & Decety, 2001 for a meta-analysis) and these studies have implicated the posterior parietal, premotor and supplementary motor cortices in motor imagery. These regions are also engaged when preparing and planning a movement (Deiber, Ibanez, Sadato, & Hallett, 1996; Rushworth, Johansen-Berg, Göbel, & Devlin, 2003), further supporting the notion that there is an overlap between motor imagery and motor planning and preparation. It has also been proposed that the primary motor cortex (M1) may play a role in motor imagery. Some studies have observed activity of M1 during imagery (e.g. Ganis, Keenan, Kosslyn, & Pascual, 2000; Lacourse, Orr, Cramer, & Cohen, 2005), whereas other studies did not find M1 activation as a function of imagery, but rather only during the execution of the action (de Lange, Hagoort, & Toni, 2005; Richter, et al., 2000). The role of M1 in functional equivalence is still an area of debate and one that warrants further investigation.

Combining the research that shows that actions produce affective responses (Hayes, et al., 2008) with the functional equivalence hypothesis (motor imagery processes are a less pronounced version of the same processes that occur during execution of overt movements; but see Hohlefeld, Nikulin, & Curio 2011), it is reasonable to assume that imaged motor actions will give rise to the same affective responses as those found in overt movement. Another reason as to why affective responses may occur when imaging an action is the supposed special relationship that imagery has with emotion. This is central to Lang's bio-informational theory of emotional imagery (Lang, 1979). Lang proposes that there are two propositions that make up an image: stimulus propositions and response propositions. Stimulus propositions describe the content of the scene that is being imaged, including descriptions of the specific features of the stimuli. Response propositions describe responses to the scene. They are modality specific assertions about behaviour, such as verbal responses, overt motor acts, and physiological responses. According to Lang (1979), learning and performance involve the linking of stimulus and response propositions and the process of imagery allows these links to be strengthened. Consequently, quality imagery should include feelings (e.g. anger, anxiety, fear) as well as physical indications (fatigue, tension, sweating) as these physiological and emotional reactions generally accompany actual performance.

Drawing on Lang's theory and the notion of functional equivalence, it has been suggested that imagery may provoke an emotional response and that this response may be similar to what would be expected to occur in a real life situation (Holmes & Collins, 2001, 2002; Kosslyn, 2001). Harrigan and O'Connell (1996) investigated facial gestures following imagery of anxiety producing events that were previously experienced. Results indicated that facial actions indicative of fear were found when anxiety producing events were experienced through imagery. The authors also found that more facial movement (e.g. eye blink) and increased arousal were observed. These findings support the proposal that emotions that are activated during overt motor actions should also be evoked during motor imagery of those actions.

Imagery Ability

Important in the effectiveness of imagery is imagery ability. This refers to how well individuals are able to form images in their minds, how vivid and realistic the images are, as well as the ability to control the images that are created. Research has shown that the ability to use imagery influences the effectiveness of imagery interventions. Therefore when using imagery in research or applied practice, it is useful to know how well an individual can image. If individuals have poor imagery ability then this may provide an explanation as to why, for example, an imagery intervention was not effective.

As well as overall imagery ability, it is useful to know about individuals' imagery ability for specific imagery modality (visual or kinaesthetic) and/or perspective (internal visual imagery or external visual imagery). Research has shown that for specific tasks, then one form of imagery may be superior to another. For example, in sports sciences, research has shown that for form based tasks (e.g. karate, gymnastics) external visual imagery is more effective than internal visual imagery. In other sports, internal imagery has been shown to be more effective. This occurs in sports where performers have to try and take an accurate "line" around a course (e.g. slalom skiing; White and Hardy, 1995).

In relation to this thesis, the knowledge of participants' imagery ability may shed some light on whether overall imagery ability is a moderating variable in the relationship between imaged motor fluency and affect, and whether a specific modality (visual or KIN) or perspective (IVI or EVI) are also moderating variables.

It has been suggested that imagery ability has two principle characteristics; vividness and controllability (Callow & Hardy, 2005; Start & Richardson, 1964). Vividness relates to the self-report of reality and clarity in the image, while controllability relates to the control that an individual has over an image. Within the sport domain, imagery ability is often measured via introspective reports of the vividness of imagery experiences through validated questionnaires. For the purpose of this thesis, the Vividness of Movement Imagery Questionnaire-2 (VMIQ-2; Roberts, et al., 2008) will be employed to assess imagery ability.

The VMIQ-2 is a revision of the Vividness of Movement Imagery Questionnaire (VMIQ; Issac et al., 1986), which is a 36 item inventory that measures movement imagery ability in both visual and kinaesthetic modalities. The VMIQ-2 further assesses the ability to visually image from an internal and an external visual perspective. Modalities are measured on a 5 point likert scale ranging from 1 *(perfectly clear and vivid, a normal image)* to 5 *(no image at all, you only know that you are thinking of a skill).* Participants use this scale to rate the vividness of an image of 12 different movements with varying degrees of complexity (e.g. walking, jumping sideways, throwing a stone into water). To calculate imagery ability or vividness of movement imagery, the VMIQ-2 requires the summation of the 12 actions completed for each of the IVI, EVI, and KIN sub-scales (the lower the score, the better the ability to image using that particular imagery type). Reliability analysis of each of the sub-scales has produced Cronbach alpha for IVI (r=.95), EVI, (r=.95) and KIN (r=.95). The VMIQ-2 has demonstrated adequate concurrent validity, with both IVI and EVI factors both significantly correlated with the Movement Imagery Questionnaire-Revised (MIQ-R; Hall & Martin, 1997) visual imagery sub-scale. Both the VMIQ-2 and MIQ-R KIN factors were significantly correlated. The construct validity of this measure is also shown to be robust.

Despite the fact that this research supports the use and validity of the VMIQ-2, and therefore imagery vividness as a measure of imagery ability, it is also worth noting that there has been criticism for using vividness to assess imagery ability. It has been suggested by Dean and Morris (2003) that there is no empirical or priori reason for the choice of vividness as a measure of imagery ability. They proposed that, rather than a single ability, imagery is a collection of abilities (namely image formation, maintenance, and transformation; Kosslyn, 1994), and that the functional role of imagery in spatial ability tests is unrelated to imagery vividness.

The suggestions put forward by Dean and Morris concerning vividness do have some validity, it is however worth noting that the authors' argument is specifically in relation to spatial ability tests, as opposed to a motor task where the creation of vivid images is important for performance (Smith & Holmes, 2004; Isaac, 1992). Intuitively it may also make sense to suggest that vividness could to some extent reflect the process of formation, maintenance, and transformation, especially if considering the role of working memory in imagery vividness. The processes of imagery formation are activated by long-term memory and the image maintenance processes by working memory resources (Ranganath, 2006). Vividness of the image is a reflection of the richness of the representation displayed in working memory (Baddeley & Andrade, 2000) and thus is likely to be the result of such processes as formation, maintenance, and transformation (Roberts et al., 2008)

While the VMIQ-2 is a valid and reliable measure, there is one issue to bear in mind. The VMIQ-2 was designed to be used by coaches and athletes from a variety of sports. Therefore, this is not a sport specific questionnaire, but rather it is specific to movement skills. Although this may be a potential drawback to the use in sports specific studies, in the present study this is a positive aspect of the questionnaire. That is, the present study is not concerned with sport specifics, but rather with emotional responses to everyday actions (performed using everyday movement skills). The VMIQ-2 provides a valid, reliable, non-invasive method of assessing imagery ability (for IVI, EVI, & KIN) for this thesis.

Structure of the thesis

Within the research literature there is evidence that fluency of actions results in affective responses. This thesis will aim to extend those findings into the imagery domain to investigate whether actual overt physical movement is required or not. This will be achieved through four interlinked investigations. Chapter 2 will investigate whether motor imagery of fluent and non-fluent actions will result in affective responses and whether there is any relationship between imagery ability and usage and fluency related affect. Chapter 3 will further investigate the role of imagery modality in affective responses to fluency of actions. And finally chapter 4 will employ facial EMG to investigate whether imaged motor fluency evokes affective responses if the task does not require attending to emotional states.

Chapter 2

Motor Imagery and Affective Responses

Dennehy, V., Hayes, A.E., & Callow, N. Imaged actions produce affective responses. Presented at 19th Cognitive Neuroscience Society Meeting, Chicago, IL, United States. March 31st – April 3rd 2012.

Hayes, A.E., Dennehy, V., & Callow, N. Imaged Motor Fluency Evokes Emotion: Evidence of Embodiment. Accepted for **2013** Psychonomic Society Annual Meeting, Toronto, Ontario, Canada. November 14-17, 2013

Previous research has demonstrated that fluency of actions influences affective judgements of objects, with fluent actions evoking more positive affect than non-fluent actions (Hayes et al., 2008). This chapter investigates whether imaged motor actions influence responses to objects in the same manner as actually performing the movement. The first study investigates whether imaged movements can produce fluency related affect, and whether this is modulated by object familiarity (Study 2.1). The second study investigates whether there is a relationship between imagery ability, imagery usage and fluency related affect (Study 2.2).

Study 2.1 – Imaged Actions Produce Affective Responses

Hayes et al, (2008) examined the influence that the quality of motor interactions has on how one feels about an object, with the conclusion that positive affect is evoked from fluent interactions with objects and that this can occur even in single interactions with objects. However, the authors could not infer if this was due to actual overt physical movement or whether mental rehearsal of the action could elicit the same response. As a result of this, the study at hand seeks to investigate whether actual overt execution of the movement is needed in order for fluency manipulations to have an influencing effect on how one feels about an object or whether merely imagining the movement (through the use of imagery) will result in an affective response.

Functional equivalence provides one possible explanation as to why the same affective response may be seen in an acting body and a non-acting body. The basic notion of functional equivalence is while imaging motor actions the neural motor network is activated, but is inhibited at a certain stage to prevent overt physical movement (Jeannerod, 2001). That is the performance of an action and the perception of an action share common cognitive and neural representations (Prinz, 1997)

Drawing on the notion of functional equivalence and the questions arising from Hayes et al., (2008), this study seeks to investigate whether affective judgements can be influenced by fluency of imaged movements. More specifically, this study aims to follow on from the study by Hayes et al., but to use imagery of a movement rather than actual overt action. Drawing from the results of the previous research (i.e. Hayes et al., the notion of functional equivalence and Lang's bio-informational theory), it is hypothesised that imaged fluent movements will result in a higher affective rating than imaged non-fluent movements. Also, this study will include a static control group (image scene with no movement) to determine as to whether any emotional response associated with motor fluency condition can be accounted for simply by differences in the visual scene.

Method

Participants

Participants were recruited from a 3rd year undergraduate sport science class within the School of Sport, Health & Exercise Sciences at Bangor University. A total of 48 right handed participants were recruited (32 males, 16 females) with an age range from 20 to 30 years (20.85 ± 1.66 years, mean ± SD). Participants were not directly compensated for partaking in this study. They were however given the chance to volunteer to partake to gain further knowledge of parts of a module content. This was not compulsory and all participants gave informed written consent prior to participation.

Apparatus

Participants were seated at a table that had two platforms on it (see Appendix 1). The platform to the participant's right was 55 x 24.4 cm and on this platform there were two pressure sensitive circular plates, aligned one in front of the other with respect to the participant’s position. Both plates had a radius of 6 cm. The plate closest to the participant (P1) was positioned 11.1 cm from the bottom of the platform to the centre of the plate and 12.4 cm from the side of the platform to the centre of the plate. The second plate (P2) was 45.6 cm from the bottom of the platform (34.5 cm directly beyond P1) and again 12.4 cm from the edge of the platform. The platform on the participant’s left was 18 x 28.7 x 7.7 cm and was placed 11.5 cm away from the other platform (edge to edge). A small yellow square (2 x 2.5cm) was positioned on the platform slightly off centre (11.9 cm from the right edge and 15 cm from the left edge) and was 7.8 cm from the top of the platform and 7.8 cm from the bottom.

Stimuli

A total of 20 stimuli were used, consisting of 5 pairs of household items of different brands (2 x tins corned beef, 2 x washing up liquid, 2 x jarred olives, 2 x staplers of different colour, 2 x shampoo) and 5 pairs of abstract block items (2 matching wooden shapes in each pair, but of different colour configurations). The household stimuli chosen were non-familiar brands to reduce any pre-existing associations with the stimuli.

Viewing Time

Previous research has indicated that duration of viewing times can have an effect on liking ratings, specifically that longer viewing times can increase liking ratings (Reber, et al., 1998, Willems & Van der Linden, 2006). For this reason the viewing time of the stimuli was controlled with the use of liquid crystal goggles (Portable Liquid crystal Apparatus for Tachistoscopic Occlusion (PLATO) visual occlusion spectacles; Translucent Technologies Inc., Ontario, Canada). These goggles allow for control of visual input for humans without a reduction in the light that reaches the eyes, thus reducing the problems of adjusting back and forth between light and dark conditions. The goggles require 1 millisecond to convert from occlusion to transparent state and 5 milliseconds to revert back to occlusion state (see http://home.ca.inter.net/~milgram/ for full details).

Tasks

Each participant completed two tasks, an imagery task followed by an action task. However, for one group of participants the imagery task is based on the action task, therefore the action task will be described first. When actually completing the Study however, the participants always performed the imagery task for all stimulus items first, and then completed the action task for all stimulus items.

Action Task: All participants performed the same action task, and always with the right hand. Participants began with their hand resting on the P1. Participants were asked to lift their hand from P1, reach out and grasp the stimulus that is resting on P2, move the stimulus to the destination platform, place it on the target, and return their hand to P1. The goggles remained closed until the experimenter pressed a button to initiate each trial. A tone sounded and 200ms later the goggles opened. The goggles remained opened for 4000ms to allow completion of the movement for the action task. After this the goggles closed and the trial was complete. This was the procedure for all 20 trials (i.e. one trial for each of the 20 stimuli).

Fluent Vs. Non-Fluent conditions

The participants interacted with the stimuli in one of two ways to perform the action task, in either a fluent manner (movement with no barriers or obstacles that must be avoided) or a non-fluent manner (a barrier or obstacle must be avoided; see Appendix 1). The barrier used was a vase of water that was placed on either the right hand side of the destination point, thus acting as an obstacle (non-fluent condition), or that was placed on the left hand side of the destination point so in no way created an obstacle to be avoided (fluent condition).

Trial Condition and Order

One item from each stimulus pair was randomly assigned to the fluent condition and the other assigned to the non-fluent condition. This meant that each complete test was comprised of a total of 10 fluent trials and 10 non-fluent trials. Each test also had a mirror test, which had the opposite fluent and non-fluent mappings for the items. This meant that across the entire group of tests (as there were an even number) each item appeared equally often in the fluent and non-fluent condition. The presentation order was randomly generated for each pair of tests, but there were constraints; two items of the same pair could not appear directly one after the other, and secondly, no more than four trials in the same condition (fluent or non-fluent) could occur in a row.

Imagery Task: Prior to the start of the Study, participants were assigned to one of two groups: Movement Imagery Group (MIG) or Static Imagery Group (SIG). Participants were assigned to a group in such a way as to ensure that there was no significant difference in the overall imagery ability between MIG and SIG, as assessed by the VMIQ-2 (Roberts, et al., 2008; see below). The VMIQ-2 was administered in two large group sessions a week apart, and experimental sessions commenced 4 weeks later and ran for 4.5 weeks. MIG were the group that in the imagery task imaged the action that would be performed at a later stage in the action task. MIG were merely instructed to image the action. An explanation of the different types of imagery (i.e. internal visual imagery (IVI), external visual imagery (EVI) and kinaesthetic imagery (KIN)) was provided to the participants. This was the same explanation as was provided to the participants when they were completing the VMIQ-2.

However, they were not asked to adhere to a set visual perspective or modality. They were free to choose whether they wanted to use visual imagery perspective (IVI or EVI), KIN or a combination. The instructions were to image the movement of their hand, starting with their hand resting on the P1, reaching out to grasp the stimulus object that was resting on P2, moving it to the target on the destination platform and returning their hand to the P1. SIG participants were instructed to image the scene as it appeared in front of them (i.e. the two platforms as they appeared in front of them). The instructions to SIG were to image the platform on their left, as well as the vase and its position, and also to image the platform on their right, including P1 and P2, and the stimulus item that was resting on P2. They were instructed to use imagery to create as clear and as vivid an image as they could of the scene.

Participants in both imagery groups were administered an imagery script (see Appendix 3) instructing them to image either themselves completing the action (MIG), or image the scene that appeared in front of them paying attention to detail (SIG). For both groups, participants were instructed to sit with their hands in their lap for the duration of the imagery task. Neither the MIG nor the SIG were aware that they would be required to complete the action task after they had completed the imagery task.

The goggles remained closed until the experimenter pushed a button to initiate the trial. A tone sounded and after 200ms the goggles opened. The goggles opened for 2500ms to allow the viewing of the stimulus item and the position of the vase (stimulus viewing duration). The goggles then closed and the participants began to image either the action (MIG) or the scene (SIG). The goggles remained closed for 4000ms to allow for imagery (imagery duration). After this time, the computer gave a verbal command to rate the item (as described below), and the goggles opened for 3000ms to allow the item to be viewed while rating (liking rating duration). The goggles then closed and the trial was concluded. This was the procedure for all 20 trials (i.e. one trial for each of the 20 stimuli).

Measures

Vividness of Movement Imagery Questionnaire-2 (VMIQ-2; Roberts, et al., 2008; see Appendix 2*):* Participants' imagery ability was assessed using the VMIQ-2. The VMIQ-2 is a revision of the Vividness of Movement Imagery Questionnaire (VMIQ; Issac et al., 1986), is a 36 item inventory that measures movement imagery ability in both visual and kinaesthetic modalities. This measure further assesses the ability to visually image from an internal and an external visual perspective. Modalities are measures on a 5 point likert scale ranging from 1 *(perfectly clear and vivid, a normal image)* to 5 *(no image at all, you only know that you are thinking of a skill).* Participants use this scale to rate the vividness of an image of 12 different movements with varying degrees of complexity (e.g. walking, jumping sideways, throwing a stone into water). It is important to note that in the context of imagery research vividness is a characteristic of imagery ability (i.e., image clarity and realism) and has been shown to be a reliable introspective quality of the image (Isaac, et al., 1986).

To calculate imagery ability or vividness of movement imagery, the VMIQ-2 requires the summation of the 12 actions complete for each of the IVI, EVI, KIN sub-scales. Reliability analysis of each of the sub-scales has produced Cronbach alpha for IVI (r=.95), EVI, (r=.95) and KIN (r=.95). The VMIQ-2 has demonstrated adequate concurrent validity with both IVI and EVI factors both significantly correlated with the Movement Imagery Questionnaire-Revised (MIQ-R; Hall & Martin, 1997) visual imagery sub-scale. Both the VMIQ-2 and MIQ-R KIN factors were significantly correlated. The construct validity of this measure is also shown to be robust. This measure was administered to each of the participants at least 2 weeks before completing the task in the lab.

Affective Rating Measure: The affective rating measure that was used was a 9 point likert scale ranging from 1 *(dislike very much)* to 9 *(like very much)*. After imaging the action (for MIG) or the scene (for SIG), the participants were asked to rate the item. Participants were instructed to rate how much they liked the item compared to other imaginable types of its kind. This was to emphasise that they were not rating how much they liked the general category of the item (e.g. a participant may dislike corned beef), but rather how much they liked this particular example of the category compared to other examples of its kind (this was in keeping with the procedure of Hayes et al., 2008). Participants reported their ratings verbally to the experimenter.

Post-Experimental Questionnaire: After completion of the imagery task, each participant filled out a post-experimental questionnaire (see Appendix 4). The first purpose of this questionnaire was to assess whether fluency manipulations consciously influenced liking ratings. This was achieved by asking participants what they based their liking ratings on. Also this questionnaire was used to assess imagery usage. Participants were asked the degree to which they felt that they used visual imagery, the form of visual imagery used (i.e. IVI or EVI) and the degree to which they felt that they used KIN. Finally this questionnaire was used to assess the participants' perception of effort for fluent / non-fluent actions and whether they had a preference for imaging one fluency condition over the other.

After the action task, another post-experimental questionnaire was administered (see Appendix 4). The main purpose of this questionnaire was to test the naivety status of the participants. The participants were invited to share their thoughts as to what they felt was the research question that this study was aiming to address. Also asked for was the participants' perception of effort and preference for fluent and non-fluent actions.

Procedure

Prior to commencement of the experiment session, participants completed the VMIQ-2 (Roberts et al., 2008). This was done in 2 large group sessions, where the participants were instructed to complete the questionnaires in silence and without conferring with any other participant in the room. The participants were informed that the nature of the study was looking at mental imagery skills in a motor task. All participants gave informed written consent to participate in this portion of study.

Participants were assigned to groups after completing the VMIQ-2. Total imagery ability scores were listed in descending order and the participants were assigned a specific subject number. All participants that were assigned odd numbers (i.e. 1, 3, 5, etc.) were assigned to one group and all those that were even numbered (2, 4, 6 etc.) were assigned to another.

Upon arriving to take part in the experiment session, the participants again received an information sheet and were again informed that the nature of the study was looking at mental imagery skills in a motor task. After written consent was acquired, the participants were seated at the table and were given verbal instructions as to the task they were going to complete. The imagery task was explained first and then completed before the action task was mentioned. At no time when referring to the movements did the experimenter label them as easy / difficult, or fluent / non-fluent so as not to unduly influence the rating measure of the participant.

The affective rating measure was explained to the participants. As mentioned above, the 1 to 9 likert scale was explained, as well as how we would like them to rate the items, i.e. not the general category.

An imagery script was read to the participants. The imagery script was first read by the experimenter with the participants imaging the actions as they were read. The imagery script was then read by the participant and then the entire action imaged. The participants were instructed to image in real time.

Participants first completed the 20 imagery trials and reported the affective ratings verbally to the experimenter. After those 20 trials a post-experimental questionnaire was completed. Then the action task was then explained to both groups. Participants were reminded to perform the task as quickly and as accurately as possible and to return their hand to the starting plate at the end of each movement. Participants completed 20 trials and after another post-experimental questionnaire was completed. The participants were thanked for their participation in the study and were debriefed as to the exact nature of the study.

Results

Participants were assigned to one of two groups as described in the methods section; MIG or SIG. Although participants were not discounted on the basis of their imagery ability, the VMIQ-2 data for both groups was analysed using an independent samples t-test to ensure that there was no significant difference in the mean imagery ability of the groups. Results revealed no difference in the overall imagery ability of both groups (t (46) = .516, p = .608), nor was there any significant difference in the imagery ability subscales for groups (see Table 1). As no perspective / modality was assigned (i.e. participants were not asked to use a particular imagery to complete the task, they were free to choose the imagery that they used), no manipulation check was carried out for adherence.

Table 1

Mean Values (SD in brackets) and Independent Samples T-Test Significance Levels for Movement Imagery Group (MIG) and Static Imagery Group (SIG) VMIQ-2 Scores

Imagery perspective & modality	*MIG* *N = 24*	*SIG* *N = 24*	*P*
Overall Imagery Ability (VMIQ-2 Total)	71.33 (22.88)	68.25 (18.22)	p = .608
External Visual Imagery (EVI)	27.88 (12.14)	28.38 (12.75)	p = .890
Internal Visual Imagery (IVI)	20.25 (7.32)	18.71 (5.54)	p = .415
Visual Imagery (EVI + IVI)	48.13 (17.37)	47.08 (15.47)	p = .827
Kinaesthetic Imagery (KIN)	23.21 (8.59)	21.17 (7.07)	p = .373

A 2x2x2 (item type x fluency x group) mixed model ANOVA was conducted on the data. Results indicated a main effect for item type (F (1, 46) = 13.380, p = .001, η^2 = .225, 1-β = .947). A closer look at the cell means revealed that affective ratings of the household items (5.27) were greater than for abstract items (4.56). For fluency there was a main effect (F (1, 46) = 9.261, p = .004, η^2 = .168, 1-β = .846), and there was also an interaction with group (F (1, 46) = 23.001, p < .001, η^2 = .333, 1-β = .997) (see Figure 1). Follow up paired samples t-tests were conducted. For MIG, the fluent condition (5.29) yielded higher affective ratings than the non-fluent condition (4.62). These were significantly different (t (23) = 4.446, p < .001). For the SIG, although the fluent condition (4.80) yielded a lower affective ratings than the non-fluent condition (4.95), this was only a marginally significant difference (t (46) = -1.857, p = .076). There were no other significant main effects or interactions observed.

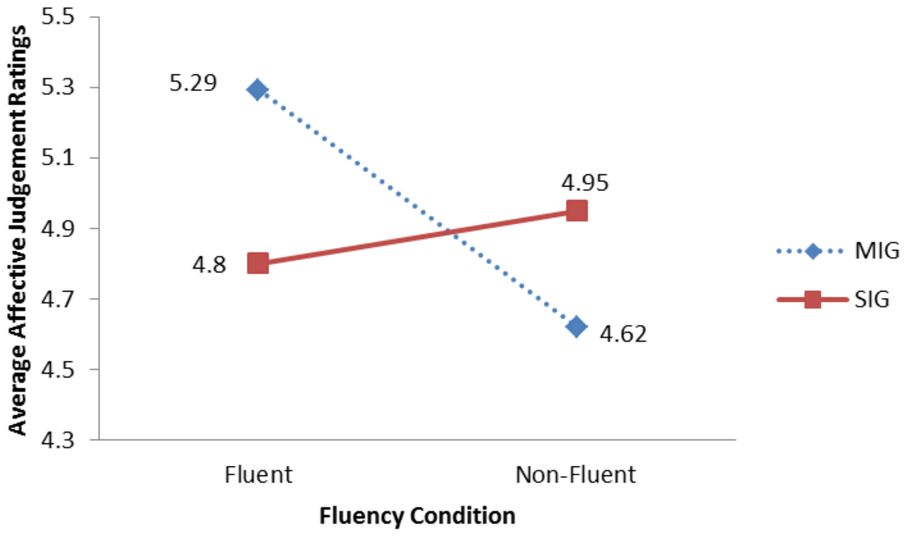

Figure 1. Interaction graph for fluency (fluent & non-fluent) x group (movement Imagery group & static imagery group) interaction

Data screening

The post-experimental questionnaires were scrutinised. On the basis of responses to two questions in the post-experimental questionnaires, participants were excluded from the data set. Firstly the participants were asked on what they based their liking ratings. Participants were excluded from the data set if their responses included mention of vase position, how easy or difficult the movement was, or any mention of fluency. Question two was to assess how I participants were to the nature of the research question. Responses that included fluency, easy difficult movements, anything that related affective judgements to vase positions or action type were excluded from the data for analysis. This reduced the sample size from 48 participants to 37 participants with 8 participants excluded from MIG and 3 excluded from SIG. Results again showed that there was no significant difference between the overall imagery ability of the two groups ($t(35) = .305$, $p = .762$) nor for any of the imagery subscales on the VMIQ-2 (see Table 2).

Table 2

Mean Values (SD in brackets) and Independent Samples T-Test Significance Levels for MIG and SIG VMIQ-2 Scores for Data after Filtering

Imagery Type	*Movement Imagery Group (MIG) N = 16*	*Static Imagery Group (SIG) N = 21*	*P*
Overall Imagery Ability (VMIQ-2 Total)	71.38 (26.89)	69.09 (19.36)	p = .762
External Visual Imagery	27.19 (13.09)	29.24 (13.24)	p = .642
Internal Visual Imagery	20.63 (8.35)	18.76 (5.80)	p = .452
Visual Imagery (EVI + IVI)	47.81 (19.71)	48.00 (16.00)	p = .975
Kinaesthetic Imagery	23.56 (8.91)	21.10 (7.01)	p = .352

The data were reanalysed again using a 2x2x2 (item x fluency x group) mixed model ANOVA. Results again revealed a main effect for item (F (1, 35) = 10.552, p = .003, η^2 = .232, 1-β = .885), with the household items rated higher (5.13) than the abstract items (4.48). There was no interaction with group or fluency. For fluency, again the results revealed a significant main effect (F (1, 35) = 5.918, p = .020, η^2 = .145, 1-β = .657) and again there was a significant group x fluency interaction (F (1, 35) = 11.626, p = .002, η^2 = .249, 1-β = .912) (see Figure 2). Follow-up paired samples t-tests were conducted on the data. For MIG, there was a significant difference in the affective rating scores for fluent and non-fluent conditions (t (15) = 2.9. p = .011) with the affective judgement ratings for the fluent conditions (5.04) being higher than the non-fluent condition (4.53). For SIG, there was no significant difference in the average affective rating scores for fluent (4.79) and non-fluent conditions (4.871) (t (20) = -1.162, p = .259).

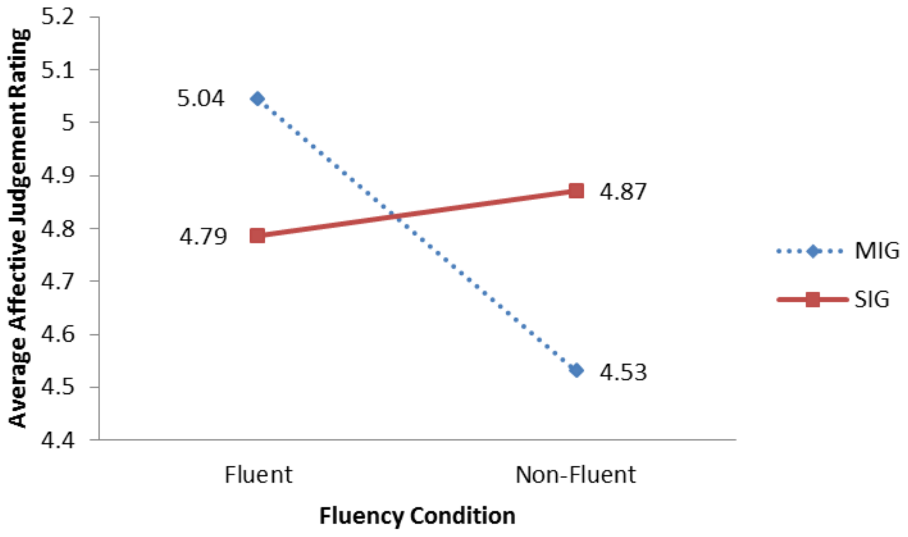

Figure 2. Interaction graph for fluency (fluent & non-fluent) x group (movement Imagery group & static imagery group) interaction

Perception of Effort

Following both the imagery task and the overt motor task, participants were asked about perception of effort for the trials they had just completed. They were asked to indicate which condition they felt was more effortful; the fluent action or the non-fluent action. An 11 point likert scale was used ranging from 0 *(fluent action was more effortful)* to 10 *(non-fluent action was more effortful)* with a further anchor at 5 *(equal effort)*. A 2x2 (task x group) mixed model ANOVA was conducted on the effort data and the results revealed a significant main effect for task (F (1, 35) = 41.043, $p < .001$, $\eta^2 = .540$, 1-β = 1.000). Results also indicated that there was a significant task x group interaction (F (1, 35) = 17.184, $p < .001$, $\eta^2 = .329$, 1-β = .981). A closer look at the cell means reveal that for the MIG, the non-fluent action was perceived as more effortful for both the imagery task and the motor task. For SIG, in the imagery task the fluent condition was perceived as more effortful than the non-fluent condition, but the opposite was found for the motor task – the non-fluent condition was more effortful than the fluent condition (see Figure 3). Follow up t-tests revealed that for MIG there was no significant difference between the perceived effort rating for the imagery task and the movement task (p = .119), but that there was a difference between SIG for the imagery and the motor task (p < .001). For the imagery task, there was a significant difference between groups (MIG & SIG) (p < .001), but for the action task there was no significant difference between groups (p = .406).

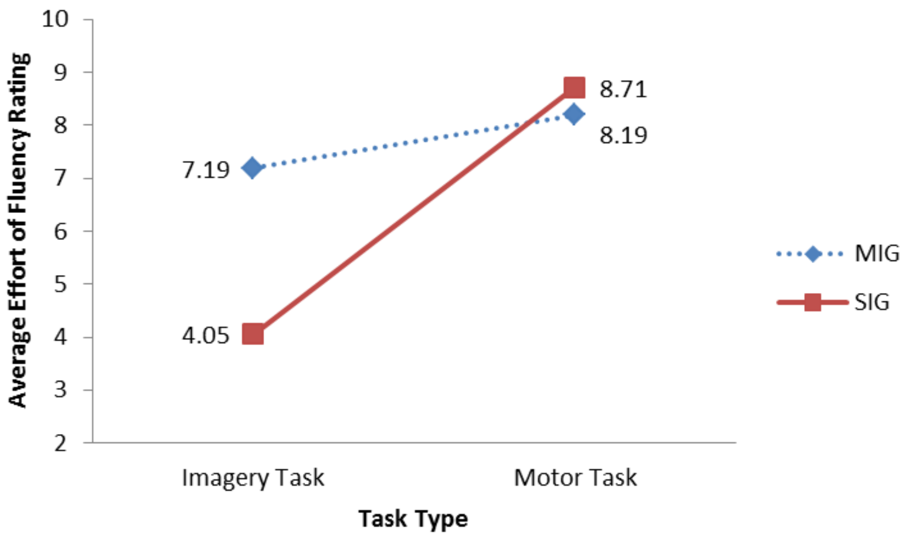

Figure 3. Interaction graph for average effort x group (movement Imagery group & static imagery group) interaction. Numbers below 5 indicate that the fluent condition was perceived to be more effortful; numbers greater than 5 indicated that the non-fluent condition was more effortful.

Imagery Preference from VMIQ-2 and Imagery Usage for Task

Results of the VMIQ-2 were examined as were those of the post-experimental questionnaire to try and gage how imagery perspectives and modality may relate to the task at hand. Analyses were run on the screened data described above.

In the VMIQ-2, imagery perspective preference was measured on an 11 point likert-scale from 0 (strong IVI preference) to 10 (Strong EVI preference), with further anchors at 3 (moderate preference for IVI), 5 (no preference) and 7 (moderate preference for EVI). For MIG; participants indicated that on average there was no preference for either imagery perspective (5.07; not significantly different from 5 (no preference), t (14) = .104, p = .919). For SIG, there was an indication for a moderate preference for IVI (3.76; significantly different from no preference t (20) = -2.876, p = .009). Between groups analysis found that for the VMIQ-2 preference there was a marginally significant difference between MIG and SIG (p = .089) with SIG having more of a preference for a particular perspective.

Imagery perspective usage was also assessed in the post-experimental questionnaire. This was done by representing the likert scale from the VMIQ-2 to the participant and asking them their imagery usage in relation to the imagery task. For MIG, results from the post-experimental questionnaire indicated that there was a moderate usage for IVI (2.80; significantly different from no preference (5) t (15) = -3.47, p = .003) when completing the imagery task. For SIG, for completing the imagery task there was a moderate usage for IVI, but this was moving closer to strong preference for IVI (2.52; significantly different from no preference, t(20) = -4.07, p = .001). For the task preference, both groups had a moderate preference for IVI and although this was slightly higher for SIG over MIG, there was no significant difference (p = .803).

The groups were compared on their preference from the VMIQ-2 and for the imagery chosen to complete the imagery task for both groups. For MIG, the perspective preference from the VMIQ-2 and the perspective used for completing the task were found to be significantly different (p = .009), with participants preferring a moderate amount of IVI to complete the imagery task. For SIG, the results indicated that there was no significant difference between imagery preference from the VMIQ-2 and perspective used for completing the task (p = .102).

For KIN, the participants were asked the same question in post-experimental questionnaire 1 as to what degree they felt that they used KIN on a scale from 0 (No kinaesthetic imagery usage) to 10 (High kinaesthetic imagery usage). Results indicated that KIN was reported to be used more by MIG (5.00) than SIG (2.48, and an independent samples t-test revealed that there was a significant difference between the two groups (t (35) = 3.08, p = .004).

Discussion

This study aimed to examine the influence of imaged action on emotion. More specifically, do we prefer items that are the object of fluent imaged actions more than items that are the object of non-fluent imaged actions?

The results yielded 3 main findings: Regardless of fluency, household items are rated higher than abstract items. Items that are the object of imaged fluent actions are rated higher than items that are the object of imaged non-fluent actions, and this result cannot be due to differences in the visual scene in the two conditions. For completion of the movement imagery task, IVI was the more favoured perspective than EVI.

Results for item type revealed a significant main effect, with familiar items being rated higher than non-familiar items. This result may be attributed to the mere exposure effect (Zajonc, 1968). This is the observations that repeated, unreinforced exposure to a stimulus is sufficient to enhance an individual's attitude towards that stimulus (Zajonc, 1968; Fang et al., 2007). In this study, the familiar objects were household items that the participants will have seen and even interacted with in their daily lives. On the other hand, the abstract stimuli will be new novel items that the participants will never have interacted with before. Thus in following with the theory of mere exposure, participants, regardless of group or fluency condition, like the items that were more familiar to them. The mere exposure effect posited that the number of times people are exposed to a stimulus will positively influence the preference for this stimulus (Zajonc, 1968). This familiarity enables the ease with which the processing of the item is achieved. In this case, individuals misattribute the ease of processing (i.e. perceptual fluency) to liking when they are not aware that the fluency comes from prior exposure (Jacoby et al., 1989).

The current study sought to investigate whether imaged actions produce an affective response, similar to the study by Hayes et al. (2008) examining whether the quality of our motor interactions with an object influence how we feel about an object (i.e. do we prefer items that are the targets of easy, fluent actions?). Indeed, the result here, that fluency did influence affect with items corresponding to fluent action liked more than items in the corresponding non-fluent condition is in keeping with the results of the same by Hayes et al. (2008). The same reasoning for this result by Hayes et al. (2008) is also applicable here.

It is proposed that action fluency evokes positive affect comparable in certain respects to previous research indicating that perceptual fluency elicits positive affect (e.g. Reber et al., 1998). Perceptual fluency has been defined as task performance facilitation as a result of prior experience with a stimulus, where the subject may not necessarily be aware of this previous exposure (Paller, 2000). Perceptual fluency is usually measured in terms of faster processing of the facilitated stimulus. In the case of this study, the results indicated that fluency did influence affect. However, the effect of fluency condition was only present with MIG and not SIG. This indicates that, in the case of the present study, it is the fluency of imaged action that elicits the emotional response.

There is no definition for action fluency within the literature, however Hayes et al. (2008) proposed a coherent explanation of action fluency. Action fluency denotes a relatively facilitated motor processing of a stimulus in comparison to processing of non-fluent action. Action fluency differs from perceptual fluency in that reaction time is not a sufficient measure of fluency. Fluency could relate to actions that are not necessarily faster but are less spatially or temporally variable, or actions the people experience as less effortful despite being kinematically equivalent to non-facilitated movement. Taking this into account, when measuring action fluency numerous factors should be considered (including, but not limited to, speed and variability of action planning and action execution and perceived effort associated with action; Hayes et al., 2008). In this case, the effects are observed even for an action that is not considered to be inherently emotional; the only difference in this task was the path that the participant's hand was required to take in order to execute the movement. Within this path, certain aspects of action fluency are taken into account including complexity of movement path, time to execute the action, and perception of effort. However, this difference in path is enough to elicit an affective response. That is that emotions may be evoked by the fluency of such simple actions (Hayes et al., 2008). In this case, the results extend the findings of Hayes et al., (2008). The previous research showed that fluency can elicit an affective response in an overt movement. Here the participants were asked to image the movement and the results indicated that the fluency of an imaged movement can also elicit an affective response.

Another implication of this study is the notion of functional equivalence and its impact on affective responses. Previous research has shown that areas in the brain that are associated with motor planning and action overlap (Grèzes & Decety, 2001). This study aimed to investigate whether merely activating these areas that overlap was sufficient to produce an affective response or whether the entire motor execution neural pathways are required. As there was an affective response when the action was imaged, the results of this study indicated that actual overt performance may not be necessary to produce an emotional response. However, this is not to say that overt movements do not influence affective responses whatsoever, merely that activating the overlapping neural pathways is sufficient to gain an affective response. To what extent imaged action and overt action influences affective responses warrants further investigation.

Imagery perspective within this study revealed an interesting result. Participants in this study were not asked to adhere to a specific modality (i.e. visual or KIN), or to a specific visual perspective (i.e. IVI or EVI). In the post experimental questionnaire, participants were asked to indicate the imagery perspective used in the completion of the task. Results indicated that, regardless of group assignment, IVI was the favoured perspective for task completion over EVI. Although this result is interesting, it is not surprising. Previous research has demonstrated that benefits of a particular imagery perspective may be due to the characteristics of the skill that is being imaged (Hardy, 1997; Hardy & Callow, 1999; White & Hardy, 1995). More specifically it was suggested (Hardy, 1997) that skills that are heavily dependent on form (e.g. precise body movements) for successful completion may benefit more from EVI. On the other hand, skills that require perceptual information to interact with other objects would benefit more from IVI. For example, White and Hardy (1995) found that for participants learning a gymnastic routine, participants using EVI demonstrated better learning and performance than those that used IVI. In the same study, a canoe slalom task was performed and those that used IVI accomplished the task with fewer mistakes then those who used EVI. As explained by Hardy (1997), imagery can exert a beneficial effect on the motor skill performance. However, this effect is only to the extent that the images that are generated supplement useful information that would have been available to the performer. Accordingly, when performing the slalom task, participants that used IVI were provided with perceptual information that they may not gain if imaging through EVI. As this task require the perceptual feedback that was required to make spatial and temporal adjustments to the fluent and non-fluent actions then the use of IVI may be of more benefit to the participants than EVI.

Participants were also asked to rate which fluency condition (i.e. fluent or non-fluent) they felt required more effort to image and also to perform. For MIG, participants felt that overall more effort was required for the non-fluent condition, both for the imagery task and the overt action task. For SIG, results indicated that in the imagery task the fluent action was felt to be more effortful, whereas for the action task the non-fluent was felt to be more effortful. Sensation of effort has previously been reported by subjects mentally executing tasks (Decety, Jeannerod, & Prablanc, 1989). This may be due to the fact that motor imagery and motor planning share neural mechanisms (Wang & Morgan, 1992). As the imaged action and motor action activate common brain mechanisms then it may be reasonable to assume that perceived exertion for an imaged movement will be reflective of the actual movement exertion. Wang and Morgan (1992) investigated imagery perspectives on the psychophysiological responses to imaged exercise. The authors found that for heart rate, perceived exertion and metabolic responses, imagery condition elicited responses similar to that of the actual exercise.

In the SIG, the imaging of the fluent condition was found to be more effortful. This may be due to cognitive load and selective attention demands. The SIG were asked to image a static scene rather than a movement scene. A lot of information is presented to the participants for them to image i.e. the item, the location of the item, the vase, the location of the vase. Kahneman (1973) developed the attentional capacity theory, and proposed that there is a limit to the amount of information that we can attend to at any one time. Therefore in this case, participants may have picked out and focused on certain pieces of information. When a person has too much information to process at one time this may lead to cognitive overload (Nideffer, 1976). Therefore in this situation, the SIG may find the non-fluent condition less effortful as there is less information to be attended to (i.e. the display spans a smaller space) in order to be able to create an image incorporating the vase and the item. The main thing to note was that in the performance of the action (for MIG and SIG) and the imaging of the action (for MIG only), participants noted that there was more effort required in the non-fluent condition. Effort was proposed to be a factor that would be needed to be taken into consideration for fluency of the task. How much the perceived exertion or perception of effort influences affective responses is an area that warrants further investigation.

In conclusion, the main aim of this study was to investigate whether affective responses could be elicited from an imaged action. Results indicated that affective ratings are higher following imaged actions that are fluent compared to imaged actions that are non-fluent. Hence, emotional responses may be elicited without the presence of actual overt movement. The effect however was only observed with the image of the movement and not the image of the scene, thus implying that this effect cannot be accounted for simply by the difference in the visual scene (i.e. change in obstacle location).

Indeed there are several questions arising from this study that may warrant further investigation. First is in relation to imagery perspective used to complete the task. In this study participants were not asked to adhere to a set perspective (IVI or EVI) or to a set modality (visual or KIN). Future studies may wish to investigate the role of a set imagery perspective or modality in affect. For example, it is an open question whether the same result could be elicited if the participants were using EVI to perform the task.

Imagery ability also warrants further investigation. Previous research has stated that everyone has the ability to image but not to the same degree (Hall, 1998). In this study, all participants were found to be good imagers (VMIQ-2 scores of less than 108; cf. Callow & Roberts, 2010). Investigation into imagery ability across all the ranges (from high imagery ability to low imagery ability) may relate to affective responses. Imagery usage when completing the task may also be looked into. How much people use imagery when performing the task may lead to variability in affective ratings given for fluent and non-fluent actions. These issues will be addressed in Study 2.2.

As well as visual imagery being examined in this study, KIN was also investigated. Results did indicate that the MIG used KIN significantly more than SIG. In past research, there is a confounding issue within the literature as to the role of KIN. Some researchers contend that KIN can only be experienced with IVI (e.g. Collins & Hale, 1997), while others (e.g. Cumming & Ste-Marie, 2001) have highlighted the fact that athletes have reported using KIN with both EVI and IVI. Callow & Hardy (2004) posited that based on Lang's (1979) bio-informational theory of coding images that it may be difficult, but not impossible to separate the visual images of the movement from the kinaesthetic ones. Study 3 will investigate further the role that KIN plays in affective responses.

Finally, in the present study, participants were asked to give their affective rating responses out loud. That is that, they were asked to explicitly attend to their liking ratings. This may in itself influence the liking ratings reported by the participants. Study 4 will investigate imagery related affect when affective ratings are measured implicitly, through the use of facial electromyography (e.g. Cannon et al., 2010).

Nevertheless, this study indicates that imaging a non-emotive action can evoke an emotional response and that positive affect can be evoked even in single imaged interactions with objects.

Study 2.2 – The relationship between imagery ability, usage and fluency dependent affect.

Study 2.1 demonstrated that fluency related affect can be obtained even in the absence of actual overt movement. When participants imaged more fluent actions, affective responses were more positive than when non-fluent actions were imaged. However, the previous study did not examine the role of imagery ability (from each of the respective VMIQ-2 subscales) or imagery usage in affective response. In Study 2.2, data from 41 participants will be added to the MIG data from Study 2.1, and the relationships between imagery ability and usage scores and fluency dependent affect will be examined.

Imagery Ability

Imagery ability has been defined as “an individual’s capability of forming vivid controllable images and retaining them for sufficient time to effect the desired imagery rehearsal” (Morris, 1997, p. 37). This indicates that the more vivid (clear and realistic the image) and controllable (ability to manipulate and control the image) the image is, the better the individual’s imagery ability. Within the literature, it has previously been suggested that everybody has the ability to generate images but not to the same extent (Hall, 1998). Moreover, Gregg, Hall and Butler (2007) suggested that those with higher imagery ability benefit more than those with lower imagery ability in relation to motor performance (see also Cumming & Ste-Marie, 2001). Indeed, in their analysis of imagery research Callow & Hardy (2005), with respect to the effects of imagery on performance, used imagery ability as a moderating variable. Results indicated that the greater the ability to image, the more effective imagery was for enhancing performance. It is the belief of Paivio (1986) that the individual differences in imagery ability are the product of experience interacting with genetic variability. In the motor domain, the main issue for researchers is the ability to predict performance in a task based on imagery ability variations. For the moment, research has produced mixed results (Hall, 2001).

Epstein (1980) looked at the relationship between individual difference in imagery ability and performance accuracies in a dart throwing task and was unable to demonstrate any relationship. Previous to this Start and Richardson (1964) measured vividness and controllability of imagery in a gymnastic skill and found no relationship between these attributions of imagery and the learning and performance of the gymnastic skill. However more recently, Ryan and Simons (1982) found a more positive result. Participants were assigned to one of six groups dependent on the amount that they reported using imagery every day. The groups were: frequent imagers (instructed to use imagery to learn a balance task through using imagery), frequent imagers instructed not to use imagery, non-frequent imagers (instructed to use imagery to learn a balance task through imagery), non-frequent imagers instructed not to use imagery, physical practice group, and a non-practice group (i.e. control group). Results indicated that imagery practice was effective for learning a task and those that used imagery improved more than those that did not use imagery. Participants that reported strong visual imagery improved more than those that reported weak visual imagery, and those that reported strong KIN improved more than those that reported weak KIN.

One reason for the mixed findings, as put forth by Hall, Prograc, & Buckolz (1985) may be due to the fact that the psychometric tools used to measure imagery ability were not designed to measure imagery ability for motor tasks. On the other hand, in more recent years, measures have been designed that will allow the experimenter to measure imagery ability in relation to motor skills (see Hall, 1998, for review). For example, Gross, Hall, Buckloz, and Fishburne (1986) administered the movement imagery questionnaire (MIQ; Hall & Pongrac, 1983) to test the imagery ability of three different groups; high visual / high KIN (HH), high visual / low KIN (HL) and low visual / low KIN (LL). Participants were tested on learning simple movement and then after one week their retention and reacquisition of the movements. Results were indicative that imagery ability is related to the learning of movements. More specifically in this case, the LL group took the most number of trials to learn the movement, the HL took an intermediate amount of trials and the HH took the least number of trials. The same trend was observed for the reacquisition task a week later although the results for a relationship between imagery ability and retention were weaker.

Imagery Perspective

Research examining the effects of imagery on the acquisition and execution of motor performance has defined imagery in terms of modalities and perspectives; visual imagery (VI) and kinaesthetic imagery (KIN), with VI modality further separated into two visual perspectives. These perspectives are internal visual imagery (IVI: where the imager is looking out through their own eyes while performing the action) and external visual imagery (EVI: where the imagery is watching themselves performing the action from an observer's position; as if watching themselves on television) (Callow, Roberts, Hardy, Jiang, & Edwards, 2013). The KIN modality is defined as how it feels to perform an action, including aspects such as force and effort involved in movement (Callow & Waters, 2005).

Research focusing on the internal and external perspective has produced somewhat ambiguous results (cf. Hardy & Callow, 1999; Callow & Hardy, 2004). For example, IVI was found to be favoured by gymnasts that qualified for the U.S. Olympic team over those that did not qualify (Mahoney & Avener, 1977). On the other hand, successful U.S. track and field athletes favoured EVI over IVI (Ungerleider & Golding, 1991). In an attempt to explain these conflicting results, it has been proposed that different imagery perspectives may have different effects on different motor tasks (see Hardy & Callow, 1999; White & Hardy, 1995; Callow & Hardy, 2004).

White and Hardy (1995) explored this notion of the effect of imagery perspectives on different tasks. The results indicated that EVI was superior to IVI in the acquisition and retention trials on which form is important. For a task that relied more on perceptual information, IVI was found to produce significantly fewer mistakes then the EVI group. However, the EVI group performed quicker than the IVI group. In this study, the results indicated that EVI was superior for tasks that form was important, but there were unclear results for the IVI.

Hardy and Callow (1999) conducted three field studies to further investigate the issue. Experiment one revealed that on the acquisition and retention of a karate kata EVI was superior to IVI. Experiment two revealed that for acquisition of a gymnastics task EVI was again superior to IVI. The final experiment involving rock climbing also showed that EVI was superior to IVI. Taken together, the results lend support to the notion of EVI being superior to IVI for performance of tasks of which form is important. More recently, Callow & Hardy (2004) investigated the use of imagery perspective on a slalom-based task where the participant had to follow a line through or around a set course. In the first experiment of the study results indicated that for a downhill slalom running course IVI produced superior performance over EVI.

Taken together, the results of Hardy and colleagues (Hardy, 1997; Hardy & Callow, 1999; White & Hardy, 1995; Callow & Hardy, 2004) indicate that for tasks upon which form is important, EVI produces superior results to IVI, whereas for slalom-based tasks, IVI produces superior results to EVI. Finally with KIN, research has indicated that it can be combined with either visual perspective so that the feeling of the movement can be combined with visual aspects (Callow & Hardy, 2004)

Regarding the determination of an affective response in relation to imaged fluent / non-fluent actions, it is not clear as to whether imagery ability, and usage will have a relationship with affective responses. Therefore the aim of this study is to determine if there is a relationship between imagery ability, usage and fluency dependent affect. The following hypotheses are proposed:

A relationship between imagery ability and fluency dependent affect (calculated by taking the difference between the average liking ratings in all the fluent action conditions and the average liking ratings in all the non-fluent action conditions) is expected. More specifically, the greater the imagery ability, the more that affective responses will depend on fluency condition. Research has indicated that the better the ability to image, the more effective imagery will be for improving performance (Issac, 1992). For example, Robin, Dominique, Toussaint, Blandin, Guillot, and Le Her (2007) tested how imagery ability could affect motor improvement following motor imagery training in tennis. Results indicated that imagery improved service return and the better the imagery ability the better the improvement. High imagery ability indicates an ability to form more vivid images. The more vivid the images, then the more likely the brain may be to interpret these images closer to actual action (Marks, 1983).

It is also expected that the more imagery is used during the imagery task, the greater will be the effect of fluency on affect. Regarding imagery type, it is expected that IVI and KIN will have a relationship with fluency dependent affect. Based on the findings from Study 2.1, it is expected that few participants will use EVI, and a relationship with fluency dependent affect is not expected.

Method

Participants

A total of 65 participants were recruited for this study (21.06 ± 3.71 years, mean ± SD). Of this 24 participants (20.92 ± 2.04 years, mean ± SD) were the same 24 participants that comprise the MIG in Study 2.1. A further 15 participants (23.53 ± 6.40 years, mean ± SD) were recruited from the 3rd year sport science class as in Study 2.1. The remaining 26 participants (19.67 ± 1.43 years, mean ± SD) were recruited from a 1st year sport science class with the School of Sport, Health & Exercise Sciences at Bangor University and received course credit for taking part. Inclusion criteria required participants be under age 30 (to avoid age-related variability in motor fluency) and right-handed. Accordingly, data from 2 participants that were over the age of 30 and 5 left-handed participants were removed from the data set to determine a final data set of 58 (20.46 ± 2.13 years, mean ± SD) right handed participants (40 Males, 18 Females). All participants gave informed written consent before partaking in the study.

The method / procedure for this study was a repeat of the method for the MIG condition in Study 2.1. All measures used were the same, except in this study the dependent measure were fluency dependent affect, and overall liking rating.

Fluency Dependent Affect

As in Study 2.1, following each imaged action, affective response was measured using a likert scale ranging from 1 *(dislike very much)* to 9 *(like very much)*. For each participant, the overall fluency dependent affect score was calculated by taking the difference between the average liking ratings in all the fluent action conditions and the average liking ratings in all the non-fluent action conditions. Additionally, fluency dependent affect scores were calculated separately for household items and abstract items.

Overall liking rating

For each participant, the overall liking rating was calculated to determine if the positivity of affective appraisals, independent of fluency condition, is related to imagery ability. This was calculated by averaging all affective ratings score for the entire trial regardless of the fluency condition and item condition.

Results

Data Screening

Data from 16 participants who may not have been naïve to the experimental hypothesis were removed from the sample as a result of answers on the post-experimental questionnaire relating to what they based their fluency ratings on and what they considered the aim of the study to be. These participants indicated that liking ratings were based on fluency or vase position, or else they guessed the aim of the study. This reduced the sample to 42 (27 males, 15 females; 20.15 ± 1.94years, mean ± SD).

In the post-experimental questionnaire the participants were asked what form of visual imagery they used. The sample was then split into those that used IVI (including those that reported minimal switching to EVI) and those that reported using EVI (including those that reported minimal switching to IVI). However when the two different groups were examined it was discovered that the sample size for those that reported using EVI to complete the task was extremely low (N = 6) and as such statistical analysis could not be conducted on this sample. Four participants also reported switching regularly between the two perspectives, so they were excluded from the analysis as the sample size was too small. So all data analyses reported here were conducted on the sample (N=32; 19 males, 13 females; 20.26±2.02 years, mean±SD) that reported using IVI for the completion of the imagery task.

A 2x2 (item type x fluency) mixed model ANOVA was conducted on the data. Results indicated a main effect for item type (F (1, 31) =7.385, p =.011, η^2 = .192, 1-β = .749). A closer look at the cell means indicated that affective ratings for household items (5.04) were greater than for abstract items (4.23). For fluency, there was a main affect (F (1, 31) =10.017, p =.003, η^2 = .244, 1-β = .866), with fluent actions (4.86) rated higher than non-fluent actions (4.42). There was no interaction between item type and fluency (F (1, 31) =.099, p =.755, η^2 = .003, 1-β = .061).

Imagery preference and imagery usage

The overall group average for imagery preference as assessed by the VMIQ-2 was 4.10, which meant that the participants preferred to engage in internal visual imagery with minimal switching to an external perspective. For imagery usage during the imagery task, this average dropped to 1.35, indicating an internal perspective with minimal switching to an external perspective, but with more of a trend towards completely internal perspective. A paired samples t-test revealed that there was a significant difference between the imagery preference of the group, as assessed by the VMIQ-2, and the form of imagery that was used in the task, as assessed by the post-experiment questionnaire (t (30) = 6.414, p <.001).

Imagery Ability, Fluency Dependent Affect Scores, and Overall Liking Ratings

Pearson's correlations were calculated to assess the relationship between imagery ability (EVI, IVI, Visual [EVI + IVI], KIN, VMIQ-2_{TOTAL}) and fluency dependent affect (see Table 3 for imagery ability descriptive statistics). The analysis revealed KIN modality and fluency dependent affect measures were significantly correlated. More specifically KIN was correlated with overall fluency dependent affect (r = -.497, p =.004), and was correlated with both household fluency dependent affect (r = -.363, p = .041) and abstract fluency dependent affect (r = -.493, *p* = .004; see Figure 4 for scatter plots). All correlations were negative, indicating that the lower the KIN score (i.e. the better KIN ability) the greater the fluency dependent affect (i.e. the more strongly items in the fluent condition were preferred to items in the non-fluent condition). There were no significant correlations for IVI ability with overall fluency dependent affect (r = -.165, *p* = .365), household fluency dependent affect (r = -.178, *p* = .329), or abstract fluency dependent affect (r = -.113, *p* = .537). Nor were then any significant correlations for EVI ability with overall fluency dependent affect (r = -.229, *p* = .207), household fluency dependent affect (r = -.230, *p* = .205) or abstract fluency dependent affect (r = -.172, *p* = .347). Analogous correlations were also calculated between imagery usage and overall liking ratings. Imagery ability scores were not correlated with overall liking ratings.

Table 3

Imagery Ability Mean Values (SD in brackets)

Imagery Type	*Mean Ability Score VMIQ-2 N = 32*
Overall Imagery Ability (VMIQ-2 Total)	84.28 (28.13)
External Visual Imagery (EVI)	31.41 (12.21)
Internal Visual Imagery (IVI)	26.16 (11.04)
Visual Imagery (EVI + IVI)	57.56 (20.10)
Kinaesthetic Imagery (KIN)	26.72 (28.13)

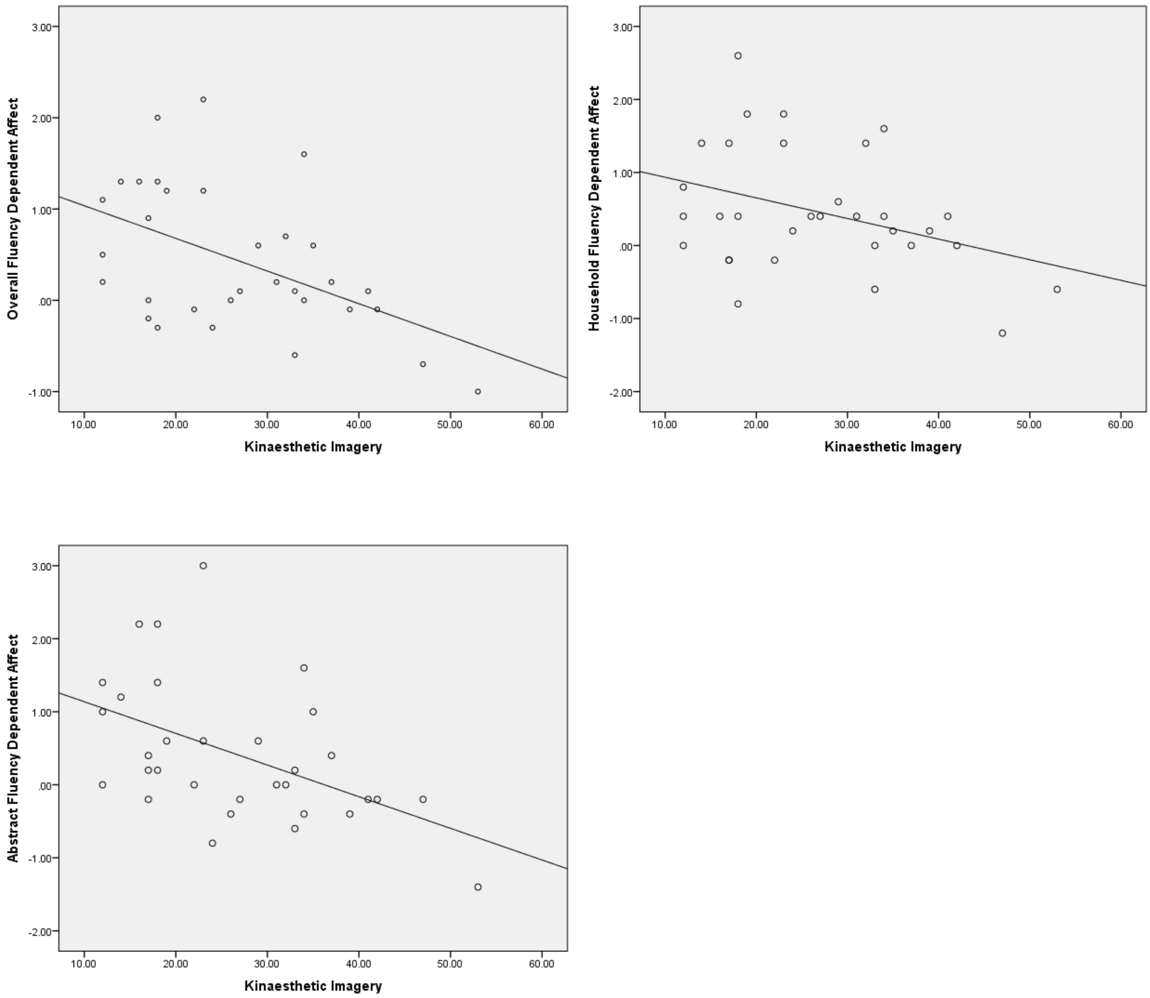

Figure 4: Scatter Plots for Relationship between KIN and Overall Fluency Dependent Affect, Household Fluency Dependent Affect and Abstract Fluency Dependent Affect.

Two participants reported scores of 49 or greater on the IVI or the KIN subscale on the VMIQ-2 questionnaire. A score of 49 corresponds to an average score per item of more than 4, indicating that the participants were unable to image items on the respective subscales. To ensure the results reported above were not unduly influenced by these potential non-imagers the data from these two participants were removed reducing the sample to 30.

With the new sample size correlations were rerun to assess the relationship between imagery ability (EVI, IVI, Visual, KIN, and VMIQ-2_{TOTAL}) and fluency dependent affect (overall, household, abstract). A marginally significant relationship was found for KIN and fluency dependent affect (r = -.338, p =.068), and a significant relationship for KIN and abstract fluency dependent affect (r = -.384, p = .036). Imagery ability was correlated with overall liking ratings. Results revealed a significant correlation between IVI and overall liking rating (r = -.401, p = .028) and a marginally significant relationship for KIN and overall liking rating (r = -.308, p = .098; see Figure 5 for scatter plot).

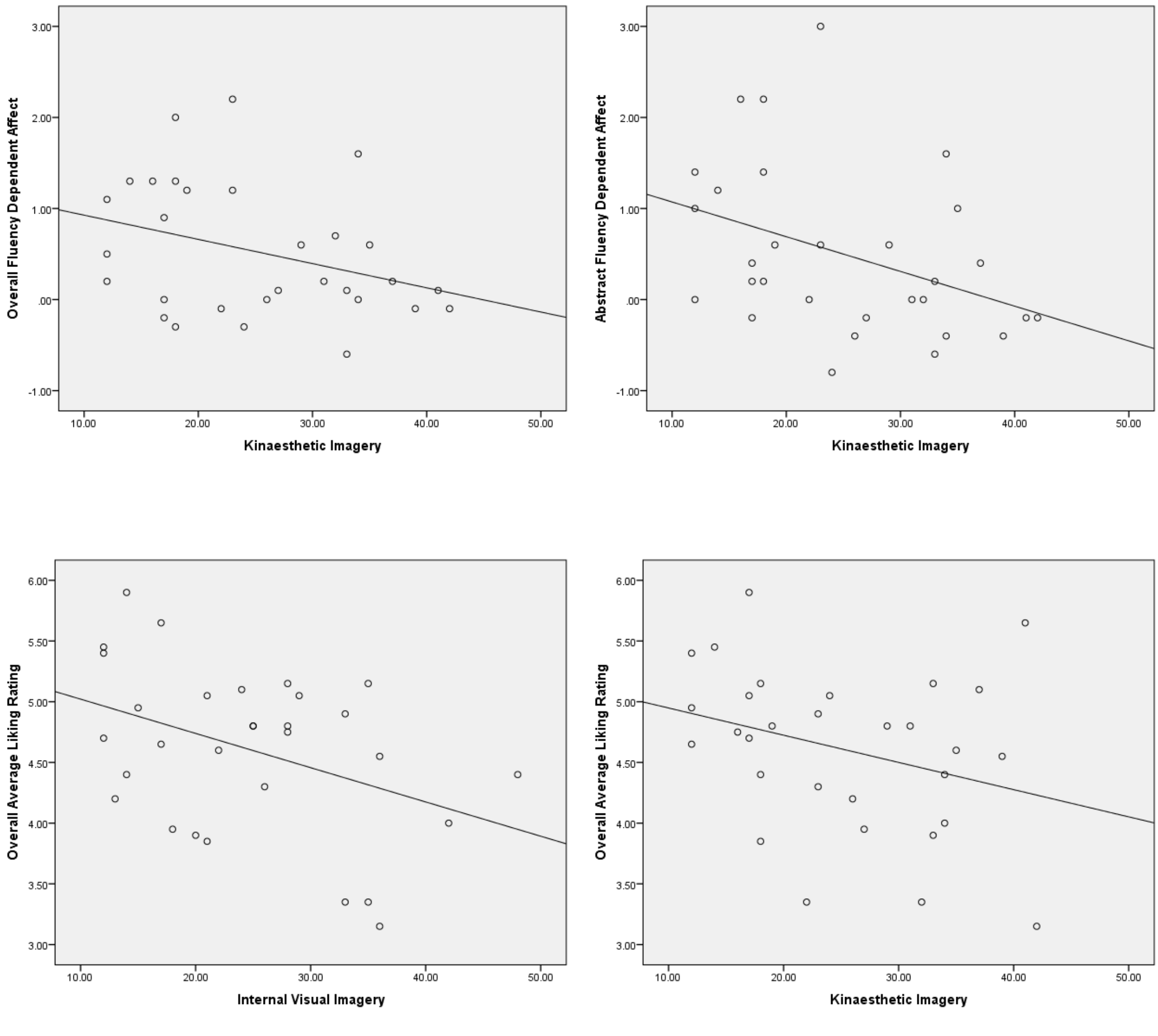

Figure 5: Scatter Plots for relationship between KIN and Overall Fluency Dependent Affect and Abstract Fluency Dependent Affect and Scatter Plots for Overall Average Liking Rating relationship with IVI and KIN.

Imagery Usage, Fluency Dependent Affect Scores, and Overall Liking Ratings

As the imagery usage variables are single item ordinal measures, Spearman's correlations were calculated to assess the relationship between fluency dependent affect and the degree to which the participants felt they used visual imagery and used KIN. Separate correlations were performed between fluency dependent affect and the degree to which they felt they used IVI for overall, household and abstract items, and fluency dependent affect and the degree to which they felt they used KIN for overall, household and abstract items. The analysis revealed no significant relationship between overall fluency dependent affect and the degree to which they felt they used IVI (r_s= .269, p = .137), household fluency dependent affect and the degree to which they felt they used IVI (r_s = .270, p = .134), or abstract fluency dependent affect and the degree to which they felt they used IVI (r_s = .194, p = .288). For KIN usage, the analysis revealed no significant relationship between overall fluency dependent affect and the degree to which they felt they used KIN (r_s= .099, p = .592), household fluency dependent affect and the degree to which they felt they used IVI (r_s = .035, p = .850), or abstract fluency dependent affect and degree to which they felt they used IVI (r_s = .141, p = .441). Analogous correlations were also calculated between imagery usage and overall liking ratings. Imagery usage scores were not correlated with overall liking rating.

Two participants reported scores of 49 or greater on the IVI or the KIN subscale on the VMIQ-2 questionnaire. Consequently the data from these two participants were removed reducing the sample size to 30. Correlation analyses were run again on the new sample size, and no significant correlations were found.

Effort

The post experimental questionnaires asked the participants to rate the degree to which condition (fluent/non-fluent) they felt it was more effortful to image. When effort was correlated with the subscales of the VMIQ-2(EVI, IVI, Visual, KIN, Total) there were no significant results. Effort was then correlated with the fluency dependent affect subscales (household item fluency dependent affect, abstract item fluency dependent affect, overall liking rating) Results showed that there was a significant effort and fluency dependent affect correlation ($r = .374$, $p = .035$), and effort and fluency dependent affect for household items ($r = .360$, $p = .043$), indicating that the more the non-fluent condition was perceived to be more effortful the greater the fluency dependent affect.

The same filters as before were further added to the IVI and KIN subscales. Results did not indicate a significant correlation with effort and the VMIQ-2 subscales, but the fluency dependent affect and effort correlations remained. That is there is a significant correlation for effort and fluency dependent affect ($r = .365$, $p = .047$) and for effort and household fluency dependent affect ($r = .369$, $p = .045$).

Discussion

The main aim of this study was to examine how fluency dependent affect is influenced by imagery ability and imagery usage. More specifically it examines whether the difference in liking ratings between those reported for fluent actions and those reported for non-fluent actions are influenced by ability to image and amount of imagery used to perform the imagery task.

Participants were not assigned to any specific visual imagery perspective, but the results were examined on the basis of what perspective that the participants reported using to complete the imagery task, that is IVI or EVI. Results indicated that only 6 people reported using EVI (including those that reported minimal switching to an internal perspective), and as a result of inadequate numbers in this group, no analyses were conducted with these data. Therefore all results that are discussed here are based on the results of the data of those that reported using IVI (including those that reported minimal switching to EVI). There are several reasons as to why the great majority of participants may have chosen to complete the task using IVI rather than EVI.

The characteristics of the task may have had an influence on the perspective chosen. Hardy and colleagues (Hardy, 1997; Hardy & Callow, 1999; White & Hardy, 1995; Callow & Hardy, 2004) investigated imagery perspective and task type. Results indicated that for tasks that depended more on perceptual information, were well learned, not complex, and do not depend on technical form may benefit from IVI (Cumming & Ste-Marie, 2001). In this task, the participants may have benefited more from the information that is provided from the IVI.

Participants were not asked to adhere to a specific perspective therefore they may have chosen the perspective that they favour more. Athletes with a preference for a particular perspective are likely to have a greater ability in that preference (Callow & Roberts, 2010), as was the case here, with participants having more of a preference that trended towards the IVI (4.28 from the VMIQ-2) that was accompanied with a significantly greater IVI ability than EVI (t (64) = 3.707, p < .001). Therefore it may be likely that perspective preference may have influenced the decision as to what perspective to use. However, this is purely speculative as there is a lack of research in the area of interactive effects of imagery perspective and preference, in relation to the characteristics of a task. That is, depending on the task (perceptual or form based) it is unclear as to whether the imagery perspective assignment needs to take account of the characteristics of the task (cf. Hardy and Callow, 1999) as well as the perspective preference or whether matching perspective to the characteristics of the task is sufficient (Callow & Roberts, 2010).

Also results indicated that when non-imagers were removed from the sample, there was a negative relationship between IVI ability and overall liking rating. That is the lower the

IVI ability score on the VMIQ-2 (lower score indicates a higher ability) the higher the overall affective ratings reported. As mentioned previously, individuals that have the ability to form images that are clear and realistic (vividness) and are better able to manipulate and control the images are deemed to have higher imagery ability (Morris, 1997). Here, the overall liking for the items is increased as imagery ability improves which may be due to participants' images being more realistic and clear. This may be analogous to a perceptual fluency effect, where imagers that are easier to perceive are judged as more liked (e.g. Reber et al., 1998).

Within the motor fluency literature it is found that difference between fluent and disfluent processing was mediated by individual differences in the tendency to activate automatically motor information stored during previous processing of a stimulus (Vrana & Van den Bergh, 1995). Imagery is viewed as a process that involves activation of perceptual-motor units in memory (Lang, 1987) and people with good imagery ability spontaneously regenerate perceptual-motor information during a cognitive or emotional task (Cuthbert, Vrana, & Bradley, 1991). Therefore if the recruitment and regeneration of perceptual motor information influences liking, this may be more evident in individuals with better imagery ability. Consistent with this idea, the imagery ability and fluency dependent affect correlation revealed a negative relationship between KIN ability and fluency dependent affect. A negative relationship indicated that the better KIN ability (lower score on the VMIQ-2, the better the ability) the greater the fluency dependent affect. That is the better the individuals ability to feel the action, the greater the difference in affective ratings between fluent and non-fluent actions.

Within the sport psychology literature, Callow and Waters (2005) have defined KIN as "imagery involving the sensations of how it feels to perform an action, including the force and effort involved in movement and balance, and spatial location (p. 444 – 445).This means that individuals feel the sensations associated with the movement that they are imaging.

However, the research into imagery modalities has focused more on the visual modality than the KIN (Kosslyn, 1994). In a discipline where movement is a common medium, the lack of research examining KIN imagery is surprising (Smyth & Weller, 1998). Specifically when considering that interviews with Olympic athletes indicate that experiencing successful performance outcomes was associated with having a 'good' feel of the actions being performed (Orlick & Partington, 1988). Additionally, Hardy and Callow (1999) found that the use of both visual imagery (i.e. internal or external) and KIN imagery produced skill acquisition and retention benefits over and above those of visual imagery alone. The limited research that is available on KIN suggests that KIN may serve a cognitive function of imagery, that is that it is associated with skill acquisition and performance (Paivio, 1985). Research suggests that in the early stages of learning mental imagery is more effective (Denis, 1985). This is due to the dominance of the cognitive processes, therefore allowing the learning of a new skill or indeed the reviving of an old one to benefit more from mental imagery (Vaez Mousavi & Rostami, 2009). Therefore, in this case, as the participants were learning the skill for the first time, KIN imagery due to its believed cognitive function may correlate with the fluency dependent affect. The better the individual's ability to use KIN, the more they are able to perceive the difference in the fluent and non-fluent actions and thus resulting in a greater difference between the affective scores reported for the different fluency conditions.

Within the cognitive neuroscience literature, there is the concept of motor imagery (MI). MI is seen as the mental simulation of a motor action in the absence of an overt physical movement (Jeannerod, 1994). Jeannerod differentiated MI from visual imagery as it shows different qualities. With MI it is the introspective feelings of moving a limb in the first person that is imaged, and not the virtual environment in a third person view (Jeannerod, 1994). Within the literature, the notion of functional equivalence (Decety & Grèzes, 1999) is broadly accepted. This is the commonality in neural pathways for motor preparation / execution and motor (kinaesthetic) imagery. Jeannerod highlighted that a key component of motor imagery was the kinaesthetic sensation. This allowed the individual to feel themselves performing the movement. Taking this and the definition put forward by Callow and Waters (2005), one may begin to see why in this case there is a relationship between KIN and fluency dependent affect. The better the participants are able to generate the feeling of movement, the better they are able to feel the difference in fluent and non-fluent actions. With this greater feeling in the image, the difference in fluency dependent affect is bigger.

There was found to be no significant correlation between degree of imagery usage (either visual or KIN) and fluency dependent affect. A possible explanation for this result may be linked to the debate regarding the order in which imagery modalities are experienced (Collins, Smith, & Hale, 1998). Athletes have reported using both IVI and EVI with KIN (Cumming & Ste-Marie, 2001) and research has highlighted the fact that the experience can be concurrent. Individuals may also switch between modalities in order to maximise their awareness of using the modalities (mono-task nature of attention; Holmes & Collins, 2001). This speed at which this switching occurs may be so fast that individuals report this as concurrent use of modalities. In relation to the present study, the reported imagery usage (regardless of modality) may not have been felt to be as strong by the participants as it may have been used in conjunction with another modality.

Another explanation as to why there was no relationship for imagery usage may be the confounding nature of some of the imagery definitions. As sport science students the participants were exposed to many different definitions of imagery. Amongst these would include the Mahoney and Avener (1977) description of internal imagery. The description includes the phrase the “person actually imagines being inside his/her own body and experiencing those sensations which might be expected in the actual situation” (p. 137). This may lead to confusion as to the difference between IVI and KIN. The present study has highlighted the fact that there is potentially a relationship between KIN ability and fluency dependent affect. But further research is warranted to examine the VI/KIN order and if this has an effect on affect. Also more care may be taken when examining the imagery usage and fluency dependent affect relationship.

One limitation of this study is it is correlational in nature, therefore causal links cannot be assumed. That is that one cannot directly infer that better kinaesthetic imagery ability causes greater difference in fluency dependent affect. It can only be concluded that greater fluency dependent affect co-occurs with greater KIN ability. To address this, the role of KIN in fluency dependent affect will be investigated using an experimental design in Study 3. Also in this study participants were asked to give their affective responses out loud. That is that they were asked to explicitly attend to their liking ratings. This may in itself influence the liking ratings reported by the participants. Study 4 will look at imagery related affect when affective ratings are measured implicitly.

Chapter Discussion

The aim of this chapter was to investigate whether imaged motor actions influence responses to objects in the same manner as actually performing the movement. Study 2.1 investigated whether fluency related affect can be produced by imaging a movement and whether this is modulated by object familiarity. The results indicated that participants preferred the household items over the abstract item, presumably because they are more familiar (Zajonc, 1968). For affective ratings, imaged actions that are fluent were rated higher compared to those that were non-fluent, regardless of item type. With the incorporation of a control group, that showed no fluency affect, it can be concluded that this effect cannot be accounted for simply by differences in the visual scene (i.e. change in obstacle location).

Study 2.2 investigated how imagery ability and imagery perspective relate to fluency dependent affect. The results indicated that for a task of this nature the imagery perspective that participants had a tendency to use to image the actions was IVI. Results also indicated that KIN ability is correlated with emotion evoked by motor fluency.

Taken together, these findings indicate that imaging non-emotive actions evokes an emotional response, and that kinaesthetic imagery ability may moderate the response.

Chapter 3

Affective responses evoked by imaged action fluency: A consideration of different imagery modalities

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The findings of the previous chapter indicated that imaged actions result in affective responses (Study 2.1) and that higher KIN ability was associated with greater fluency dependent affect (Study 2.2). However, Study 2.2 was a correlation study and caution must be taken when interpreting correlation coefficients as they give no indication of the direction of causality. Causality between two variables also cannot be assumed as there may be another variable (either measured or unmeasured) affecting the results (i.e. a confounding variable). To rule out confounding variables an effect should be present when the cause is present and the effect should be absent when the cause is absent. The following study will attempt to infer causality through comparison of controlled situations (in this case imagery modality) where the cause (KIN) is present in one and the cause is absent in another.

Study 3: The Role of Imagery Modality in Fluency Dependent Affect

Although the previous studies (within this thesis) indicate that affective responses may be elicited from imaged actions, the previous studies did not control for imagery modality (kinaesthetic and visual imagery) or imagery perspective (internal or external). In the previous studies, participants were given an explanation of the different imagery perspectives and modalities, but were free to choose which modality or perspective to use. Therefore the aim of this study is to investigate the role of imagery modalities, namely visual and kinaesthetic, in affective responses.

Suinn (1976) proposed that imagery can involve any of the sensory modalities: visual, kinaesthetic, auditory, olfactory, or tactile modality. Researchers in imagery who have focused on imagery ability and modality have targeted visual and kinaesthetic imagery (Murphy & Martin, 2002). However within the research there is some confusion between perspective and modality.

For the purpose of this study, kinaesthetic imagery will be defined as involving the "sensations of how it feels to perform an action, including the force and effort involved in movement and balance, and spatial location" (Callow & Waters, 2005, p. 445). The visual perspective that will be used is internal visual imagery. Internal imagery was chosen as the visual perspective for two reasons; firstly, research has found that for tasks that require precise spatial and temporal locations, internal imagery was superior to external imagery for task execution (White & Hardy. 1995). Secondly, in the previous studies (Study 2.1 & Study 2.2) when participants were free to choose the perspective or modality they used to complete the task, results indicated that participants favoured the use of internal imagery to perform the task. For the purpose of the present study IVI will be defined as where the imager is looking through their own eyes while performing the action.

To summarise, this study will test whether the quality of an imaged motor interaction with an object will influence an emotional response to the object, and whether this is moderated by imagery modality. We hypothesise that the more fluent the interaction with the object, the more positive the affect towards that object. We also hypothesise that imagery modality will moderate the relationship, and based on the findings of Study 2.2 that the KIN modality will result in a greater affective response than the visual modality

METHOD

Participants

Participants were recruited from within the School of Sport, Health, & Exercise Sciences at Bangor University. A total of 72 right handed participants were recruited (52 male, 20 females) with an age range of 18 –27 (20.23 ± 1.54 years, mean ± SD). Informed written consent and institutional ethics was obtained.

Apparatus

This study used the same apparatus as used in the studies in chapter 2 of this thesis.

Stimuli

This study used the same stimuli as used in the studies in chapter 2 of this thesis.

Viewing Time

The viewing time for this study was the same as in the studies in chapter 2 of this thesis.

Imagery groups

Participants were randomly assigned to one of three groups; an IVI only group (IVI), a KIN only group (KIN) and a combination of IVI and KIN group (IVI/KIN). All tasks (imagery and action) were the same for each group, they only differed on the imagery modality that they were instructed to use. Imagery modalities were explained in keeping with the instructions of the VMIQ-2. All modalities (i.e. EVI, IVI and KIN) were explained to each participant to aid understanding and in an effort to reduce the confounding of modalities.

Tasks

Participants completed the same tasks as Study 2.2 of this this thesis, however for the present study, participants were assigned to a specific imagery group and were asked to adhere to this specific imagery modality(s) when completing the imagery task.

Fluent Vs. Non-Fluent conditions

The fluent and non-fluent conditions were the same as those described in the studies in chapter 2 of this thesis.

Trial Condition & Order

The trial conditions (i.e. the assignment of household and abstract items to fluent and non-fluent conditions) and the presentation order of trials were constructed in the same as those described in the studies in chapter 2 of this thesis.

Measures

Vividness of Movement Imagery Questionnaire-2 (VMIQ-2; Roberts et al., 2008): Participants imagery ability was assessed using the VMIQ-2.

Affective Rating Measure: The affective rating measure was the same as that used by Hayes et al., (2008) and Studies 2.1 and 2.2 of this thesis.

Post-Experimental Questionnaire: After completion of the imagery task, each participant filled out a post-experimental questionnaire (see Appendix 6, 7, & 8). This was used to assess the choices that were the bases of the liking ratings, visual imagery use and perspective, KIN use, as well as preference and perception of effort for fluent / non-fluent actions. This was also used as a measure for data filtering (as will be explained further in the results section). After the action task, another post-experimental questionnaire was filled out (see Appendix 6), again assessing preference and perception of effort for fluent / non-fluent actions. Also, in this questionnaire, participants were asked their thoughts as to what the nature of the study was.

Procedure

The procedure of the study was the same as that for Studies 2.1 and 2.2 of this thesis (see Appendix 5 for imagery scripts for each group).

Results

Imagery Ability

A one-way ANOVA was used to compare the imagery ability of the groups and to ensure there was no difference in the abilities of the groups (see Table 4). Results indicated that there was no significant difference in imagery ability between the groups for EVI, IVI, Visual, KIN, or total imagery ability (VMIQ-2 Total).

Table 4

Mean Values (SD in brackets) and One Way ANOVA Significance Levels for Imagery Groups VMIQ-2 Scores

Imagery Type	*IVI Group N=24*	*KIN Group N = 23*	*IVI/KIN Group N = 22*	*P*
Overall Imagery Ability (VMIQ-2 Total)	83.25(21.88)	74.17 (19.24)	72.00 (20.63)	p = .150
External Visual Imagery (EVI)	32.17(9.76)	28.35 (10.32)	30.23 (10.45)	p = .442
Internal Visual Imagery (IVI)	25.54(7.69)	22.13 (6.58)	20.73 (6.27)	*p = .057*
Visual Imagery (EVI + IVI)	57.67(15.10)	50.48 (14.86)	50.95 (15.67)	p = .201
Kinaesthetic Imagery (KIN)	25.58(10.18)	23.70 (7.07)	21.04 (7.53)	p = .195

After some of the data were filtered out (see data screening section below) imagery ability for all 3 groups was again compared using a one-way ANOVA (see Table 5). Results indicated that there was a significant difference for IVI ability between the groups, F (2, 51) = 3.352, p = .043. Tukey HSD revealed that this difference lay between the IVI group and the IVI/KIN group (p= .046), with the IVI group reporting a lower IVI ability (26.60) than the IVI/KIN group (21.22). However, within this ANOVA the sample sizes are not equal (IVI = 18, KIN = 16, IVI/KIN = 20). As a result SPSS uses the harmonic mean of the group and this does not guarantee Type I error levels. As such, the ANOVA was re-run using Gabriels as post hoc as this is designed to cope with situations where the sample sizes are different.

The one-way ANOVA revealed again that there was a marginally significant difference in the IVI ability for the groups, F (2, 51) = 3.352, p = .043. Gabriels post hoc however, indicated that the difference in the IVI ability between the groups were not significant, with the IVI and IVI/KIN group now indicating that p=.052.

Table 5

Mean Values (SD in brackets) and One Way ANOVA Significance Levels for Imagery Groups VMIQ-2 Scores After Data Filtering

Imagery Type	*IVI Group N=23*	*KIN Group N = 18*	*IVI/KIN Group N = 20*	*P*
Overall Imagery Ability (VMIQ-2 Total)	85.05(22.94)	74.06 (19.78)	73.39 (21.05)	p = .181
External Visual Imagery	32.80(10.47)	28.75 (11.15)	30.06 (10.37)	p = .506
Internal Visual Imagery	25.60(7.81)	22.38 (5.80)	21.22 (6.25)	p = *.043*
Visual Imagery (EVI + IVI)	59.35(15.74)	51.13 (15.58)	51.28 (15.48)	p = .190
Kinaesthetic Imagery	25.70(10.49)	22.94 (6.48)	22.11 (7.87)	p = .409

Affective Responses

A 2x2x3 (item x fluency x group) mixed model ANOVA was conducted on the data. This was done firstly for all 72 participants (24 participants x 3 groups). The results were inspected for main effects for item, main effect for fluency and then for interactions.

For item, results indicated that there was a significant main effect (F (1, 69) = 10.746, p = .002, η^2 = .135, 1-β = .898). Further examination of the cell means indicated that the average household item affective rating (4.75) was greater than that of the average abstract affective rating (4.18). The ANOVA did not indicate an item x group interaction (F (2, 69) = .874, p = .422, η^2 = .025, 1-β = .195).

For fluency, results indicated that there was a significant main effect (F (1, 69) = 22.075, p > .001, η^2 = .242, 1-β = .996), with further inspection of the cell means indicating that the average affective rating for fluent actions (4.69) was greater than the average affective ratings for non-fluent actions (4.25). Analysis also revealed a fluency x group interaction (F (2, 69) =3.486, p = .036, η^2 = .092, 1-β = .633) (See Figure 6). To determine the nature of this interaction, separate analyses were run on each of the groups.

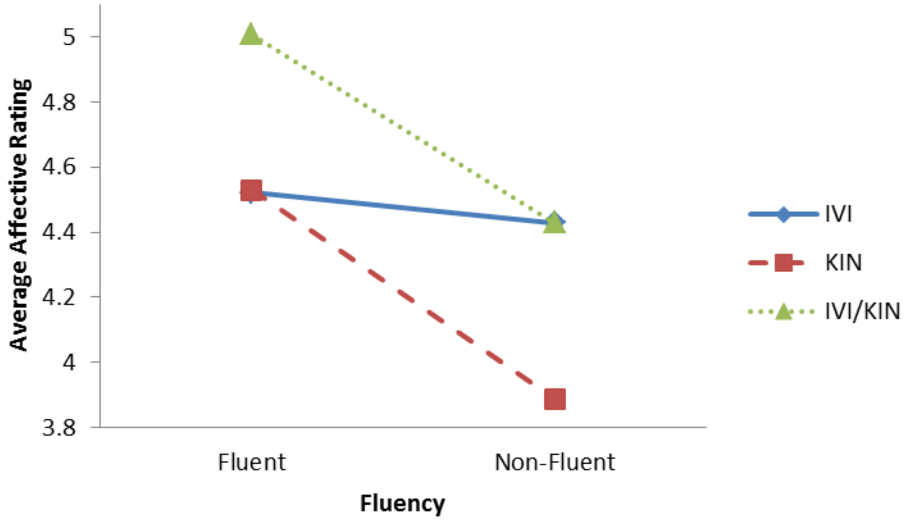

Figure 6. Fluency (fluent & non-fluent) x Group (IVI, KIN, & IVI/KIN) Interaction

For IVI group, fluent actions (4.52) were rated higher than non-fluent actions (4.43), but analyses indicated that there was no main effect for fluency (F (1, 23) = .695, p = .413, η^2 = .029, 1-β = .126).

For KIN group, results indicated that there a main effect for fluency (F (1, 23) = 9.005, p = .006, η^2 = .281, 1-β = .820). A closer look at the cell means revealed that the average affective rating for the fluent condition (4.53) was greater than for that of the non-fluent condition (3.89).

For the IVI/KIN group, ANOVA revealed that there was a main effect for fluency (F (1, 23) = 16.592, p < .001, η^2 = .419, 1-β = .974). Cell mean inspection revealed that the average affective rating for items associated with the fluent action (5.01) was greater than for those associated with the non-fluent action (4.43).

Results did not reveal any other significant interactions (i.e. there was no item x fluency x group interaction).

Data Screening

The same ANOVA was re-run on the data a second time with some of the data filtered out. As mentioned, after the completion of the tasks the participants filled out questionnaires. Within these, they were asked to describe factors used in making their choices as regards the liking rating, and also to give their best guess as to what the purpose of the study was. These questions were coded according to whether the participant mentioned using fluency or vase position as a factor in their decision making, or if they guessed that the purpose of the study was fluency related affect. The data set was reduced to n = 62 (IVI = 23, KIN = 18, IVI/KIN = 20).

Also within this study, imagery modality was one of the main focuses. Participants were asked to adhere to a particular imagery modality. Manipulation checks were used in the post-experimental questionnaire to see how well the participants followed this. In the IVI group, participants that reported using low visual imagery, EVI, or high levels of KIN were filtered from this group. In the KIN group, those that reported using high levels of visual, EVI or low levels of KIN were filtered from this group. For the IVI/KIN group, participants reporting using low visual, EVI or low KIN were filtered from the group. The data set was reduced to n = 57 (IVI = 20, KIN = 17, IVI/KIN = 20) and the analysis was rerun.

For item type results indicated a main effect (F (1, 54) = 12.591, p = .001, η^2 = .189, 1-β = .936). Further examination of the cell means indicated that the average household item affective rating (4.73) was greater than that of the average abstract affective rating (4.05). The ANOVA did not indicate an item x group interaction (F (2, 54) = .136, p = .873, η^2 = .005, 1-β = .070).

For fluency affective ratings, the ANOVA indicated that there was a main effect for fluency (F (1, 54) = 14.332, p > .001, η^2 = .210, 1-β = .961), with further inspection of the cell means indicating that the average affective rating for fluent actions (4.58) was greater than the average affective ratings for non-fluent actions (4.20). Analysis also revealed a fluency x group interaction (F (2, 54) = 4.356, p = .018, η^2 = .139, 1-β = .731) (See Figure 7). Separate analyses were run on each of the groups to assess the nature of this interaction.

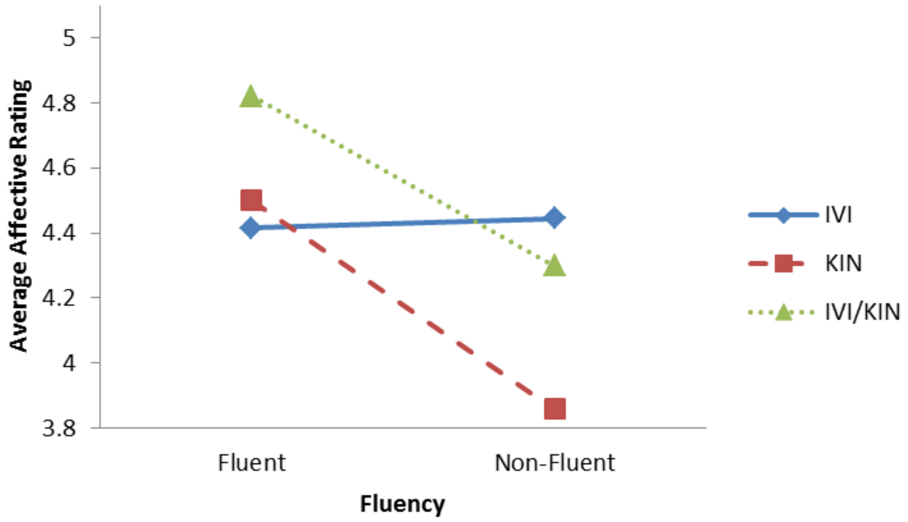

Figure 7. Fluency (fluent & non-fluent) x Group (IVI, KIN, & IVI/KIN) Interaction

For IVI group, the affective rating for the fluent condition (4.42) were not as high as those for the non-fluent condition (4.45), however there was no main effect for fluency (F (1, 19) = .111, p = .743, η^2 = .006, 1-β = .062)

For KIN group, results indicated that there was a main effect for fluency (F (1, 16) = 6.389, p = .022, η^2 = .285, 1-β = .661). A closer look at the cell means revealed that the average affective rating for the fluent condition (4.50) was greater than for that of the non-fluent condition (3.86).

For the IVI/KIN group, ANOVA revealed that there was a main effect for fluency (F (1, 19) = 10.515, p = .004, η^2 = .356, 1-β = .868). Cell mean inspection revealed that the average affective rating for items associated with the fluent action (4.82) was greater than for those associated with the non-fluent action (4.30). There was no significant item x fluency interaction (F (1, 19) = .153, p = .700, η^2 = .008, 1-β = .066).

Results did not reveal any other significant interactions (i.e. there was no item x fluency x group interaction).

DISCUSSION

The purpose of the present study was to investigate the role of imagery modality in the fluency dependent affect that is evoked by imaged actions. More specifically, the roles of IVI and KIN were investigated, when used independently (i.e. just IVI or KIN on their own) and when combined (i.e., IVI and KIN together). Also examined was the role of item type in fluency affect. The data were analysed to determine if the household items (recognisable items to the participants) and abstract items (less recognisable to the participants) differed when it came to fluency related affect and whether this can be accounted for by reasons other than item recognition. The results for item type will be discussed first then the results for fluency of movement.

Results indicated that, for item type, the more familiar household items were rated higher than the non-familiar abstract items. This can be explained by the mere exposure effect (Zajonc, 1968), which is the observation that repeated, unreinforced exposure to a stimulus is sufficient enough to enhance an individual's attitude towards that stimulus (Zajonc, 1968; Fang et al., 2007). This mere exposure effect can be explained from both a cognitive perspective and an affective perspective. Both explanations are based on the concept of ‘fluency’ (the ease with which information is processed), but differ in their underlying mechanisms.

The cognitive perspective is explained by the perceptual fluency / misattribution model (PF/M), suggesting that if an individual is unaware that enhanced perceptual fluency is a result of prior exposure to the stimulus, then they may misattribute it to liking for the stimulus (Fang, Singh, & Ahlualia, 2007; Nordhielm, 2002). More specifically, people will form metacognitions on the basis of personal fluency experience (e.g. concluding that if they recall a stimulus quicker, then they like it better), and thus misattribute the personal fluency experience to evaluation of the stimuli (Bornstein & D’Agostino, 1992, 1994; Fang et al., 2007).

On the other hand, the affective perspective is explained by the hedonic fluency model (HFM). HFM focuses specifically on preference judgements. The model suggests that the dynamics of the information processing (i.e. processing fluency) are hedonically marked. The same stimulus can be evaluated more positively when it is processed with higher levels of fluency rather than lower levels of fluency, as higher fluency levels are indicative of more positive states of the environment or cognitive system (Winkielman & Cacioppo, 2001; Winkielman et al., 2003). In this case, the item effect was only evident in the presence of IVI (i.e. visual imagery), which supports the idea that this result is related to (visual) perceptual fluency.

Results also indicated that there was a main effect for fluency with imaged fluent actions rated higher than imaged non-fluent actions. Importantly, the fluency effect interacted with group. The fluency effect was only evident in the presence of KIN. Hence this suggests that merely visually imaging the fluent and non-fluent actions is not enough to evoke an affective response. For the affective response to be present, the feeling of the movement must be incorporated (i.e. the image must contain a kinaesthetic component).

As noted previously, the mental simulation of a specific action without any corresponding motor output is motor imagery (MI; Jeannerod, 1994). It is now well established that MI may be subdivided into visual imagery (VI) and KIN. With the introduction of brain mapping techniques it has been shown that actions, whether imaged or executed share common neural substrate (e.g. Decety, et al., 1994; Guillot et al, 2008), but it has also been suggested that VI and KIN may recruit different neural substrates (e.g. Binkofski et al., 2000; Solodkin, Hlustik, Chen, & Small, 2004).

A recent study by Guillot et al. (2009) investigated whether good imagers recruit comparable or distinct neural substrates during both visual imagery (VI) and KIN of complex hand movements. Results indicated that VI (participants were instructed to VI from an internal perspective) and KIN activated similar neural networks, but in addition to these similarities there was also evidence of differences in brain activation. VI of body part movements shared common occipital substrates with visual perception, whereas KIN showed activation of several motor-related regions. Taken together the results indicated that different types of MI are mediated by distinct neural networks involving the cerebral regions related to the predominant sensory systems supporting the content of the MI (Guiillot, et al., 2009).

When taken with the present results the following can be inferred. The Item main effect was only present during IVI. As IVI is a visual imagery modality, the visual system was active as the participants attended to the visual cues of the stimulus items. As such the items that were liked more were the items that were more familiar visually.

On the other hand the fluency effect was only evident in the presence of KIN. The motor simulation process relating to form and timing of actual movement are included to a greater extent in KIN (Michelon, Vettel, & Zacks, 2006). The integration of the motor programme and its subsequent sensory feedback that is more available during KIN than IVI

(Koch, Keller, & Prinz, 2004; Prinz, 1997; Wulz & Prinz, 2001) is evidently the moderator for this affect evoked by fluency.

The group that used both IVI and KIN showed both a main effect for item and for fluency. This may be due the fact that when they imaged the action both the visual perception processes of IVI and the motor simulation process included in KIN were activated and hence resulted in an affective response for item and an action fluency affective response. Interestingly, the effects of the two imagery modalities did not interact. That is, the effect of fluency in the KIN and the IVI/KIN groups were the same. Imagery modality appears to make separate, independent contributions to affective responses to imaged action.

There are some limitations to the present study. Firstly, in this study, the compliance of the participants as regards adherence to imagery instructions was measured through self-report. This is a methodological concern as participants may encounter difficulty dissociating VI and KIN, despite having received specific instructions and understanding the difference between the modalities. Guillot et al. (2009) incorporated the use of both subjective and objective measures to make sure that the participants complied with the instructions. To establish motor imagery ability the authors used four measures; the movement imagery questionnaire (MIQ-R, Hall & Martin, 1997), movement durations were recorded for physical action performance and imaged action performance, autonomic nervous systems activity was simultaneously and continuously recorded during each trial and finally the participants were required to rate the vividness of the imagery. Future studies may use a combination of subjective and objective measure in this case to ensure compliance with imagery instructions.

Another possible limitation of the present study was that participants were not assigned to their respective groups on the basis of imagery preference. That is some of the participants in the groups may have had a preference for external visual imagery and this task required the use of internal visual imagery. The limitation here is that for an affective response to occur, the visual imagery perspective used may need to be matched to both the characteristics of the task and the visual perspective preference of the individual. However, recently Callow, Roberts, and Amendola (2012) examined whether imagery preference would moderate the effects of external visual imagery on a form based task. Based on imagery ability and preference, the participants were assigned to one of three groups; external visual imagery preference, internal visual imagery preference, or a control group (with equal numbers of IVI and EVI preference). The results indicate that both imagery groups improved performance relative to the control group, but there was no difference between the imagery groups. These results indicated that there is no interactive effect between EVI and visual imagery preference for a form-based task. Thus this implies that as EVI significantly improves performance in form based tasks (e.g. White & Hardy, 1995; Hardy & Callow 1999), then regardless of imagery perspective preference, interventions should be implemented with external visual imagery. In relation to the present study, although the participants were not assigned to their groups based on perspective preference, the findings of Callow et al. (2012) suggest that preference does not moderate the effects of imagery when imagery perspective is appropriate to task demands. As a task such as the one completed in this study benefits from an internal visual imagery perspective (White & Hardy, 1995) then this is the perspective that should be implemented regardless of visual imagery preference. Of note here however is that Callow et al.'s findings were related to a form based task and although it makes intuitive sense that the same would apply for tasks that require positioning the body in relation to other external visual features, this has yet to be established.

Finally participants were asked to give their affective rating responses out loud and as such they were explicitly attending to their liking ratings. This may in itself influence the liking ratings reported by the participants. Study 4 will investigate imagery related affect when affective ratings are measured implicitly, through the use of facial electromyography (e.g. Cannon et al., 2010).

In conclusion, the findings of the present study are consistent with the notion there is a relationship between fluency and affect and that this relationship is moderated by imagery modality. More specifically it is KIN imagery that moderates the relationship.

Chapter 4

Emotional response to imaged motor fluency occurs implicitly: Evidence from Facial Electromyography

Dennehy, V., Hayes. A.E., & Boehm, S.G. Emotional response to imaged motor fluency occurs implicitly: Evidence from Facial Electromyography. Presented at Psychonomic Society Annual Meeting, Toronto, Ontario, Canada. November 14-17, 2013.

In the previous studies in this PhD, emotional responses to imaged motor actions have been measured by asking participants to give affective ratings for the items that they have imaged interacting with. This is a rather indirect way to measure emotional responses and the affective rating measure has two disadvantages: 1) Participants gave their affective response only at the end of each trial, and 2) the affective rating task directs participants' attention to their emotional state, which may in itself influence the affective ratings reported by the participants. One of the considerations from the previous studies has been that a more direct measure of affective responses would enable further investigation into how imaged motor fluency influences affect. Facial electromyography (fEMG) has been used previously as a method to directly measure affective responses during perceptual fluency experiments (Winkielman & Cacioppo, 2001; Winkielman, Halberstadt, Fazenderio, & Catty, 2006) as well as a motor fluency experiment (Cannon et al, 2010). This study will use this technique to examine how the emotional response develops over time and will investigate whether imaged motor fluency results in an affective response even when participants are not attending to their emotions.

The vast majority of previous fEMG experiments have used stimuli or tasks that are overtly emotional. Experimental designs have required that participants passively view emotional facial expressions (e.g. Dimberg, 1982; Dimberg, Thunberg, & Elmehed, 2000), view strong emotive stimuli (e.g. Dimberg, 1986) or affectively rate stimuli (e.g. Winkielman & Cacioppo. 2001; Winkielman et al., 2006). It is important to note, however, that it has also been established that EMG is capable of measuring affective facial expressions when the stimuli are not inherently emotional, and in the absence of a verbal affective response, that is when the participants are focused on an emotion irrelevant task (Cannon et al., 2010). This chapter will use fEMG to investigate whether imaged actions that are not inherently emotional will result in an affective response.

To explain the fEMG technique, first the general EMG technique will be reviewed, and then the application of f EMG to the study of emotion will be considered.

Electromyography

To understand EMG, it is helpful to review some basic components of muscle function. Muscles perform many different functions (Smith & Kier, 1989); their orchestrated activation maintains posture, causes reflexive movement and produces both voluntary and spontaneous movements (Morecraft, Stilwell-Morecraft, & Rossing, 2004). This generation and transmission of force is the role of the muscles in the human body. Prior to the production of this force, a small electrical current is generated by fibres within the muscles and these fibres are activated by motoneurons. A number of muscle fibres within the muscle are innervated by a single motoneuron at an area of the muscle known as the innervations zone (Tassinary, Cacioppo, &Vanman, 2007). Within the muscle the most elementary functional unit, consisting of the muscle fibres and their controlling motoneuron, is the motor unit (Liddell & Sherrington, 1925; Eccles & Sherrington, 1930). When muscles start to contract at low force, smaller motor units (with fewer muscle fibres) are activated, but the larger motor units (with many muscle fibres) are not activated. As more of the larger motor units are activated then the force of the muscle contraction becomes stronger. This relationship is explained by the concept known as the size principle (Henneman, 1980), where progression of muscle force occurs in a precise order starting with recruitment of the smallest units first and then recruiting larger units as more muscle force is required. In addition, the firing rates of motor units that were already recruited increase (De Luca & Erim, 1994). More specifically, small motoneurons discharging intermittently and then discharging more frequently is regarded as the cause of the initial force of contraction that the muscle produces. It is the depolarization of the larger motoneurons within a motoneuron pool along with increases in the firing rate of the smaller, already active motoneurons that is indicative of larger muscle contractions (Tassinary et al., 2007).

Depolarization of a motoneuron results in the release of the neurotransmitter acetylcholine (ACh) at the motor end plates (flattened end of a motoneuron that transmits neural impulses to a muscle). However, this is quickly metabolised by the enzyme acetylcholinesterase (AChE), thus reducing stimulus to the muscles and limiting muscle activity. For the propagation of this muscle activity (muscle action potentials) a continuous efferent discharge is required. A muscle fibre is innervated by a nerve fibre to produce a muscle action potential. This single nerve fibre can innervate several muscle fibres, all part of a single motor unit. Therefore when the motoneuron is activated all the muscle fibres under its control produce a signal referred to as the motor unit action potential (MUAP; Tassinary, et al., 2007). Some of the changing electromagnetic field associated with these processes passes through the extracellular fluids to the skin and it is this activity that gives rise to the EMG signal (Fridlund & Cacioppo, 1986; Tassinary, et al., 2007).

Relevant to the present investigation, an example of this process is the smile. A smile occurs when the motor cortex triggers activation of the motoneurons connected to the facial muscles. The activated facial muscles, when contracted, lift the corners of the mouth (*zygomaticus major and minor*), the *risorius* pulls the sides of the mouth laterally, *levatorlabiisuperioris* raises the corner of the lip and nose, while the angle of the mouth is controlled by the *levatoranguliorois* and the eyes are closed slightly by the *orbicularis oculi*. On the other hand, during frowning, the *corrugater supercilii* and the *procerus* furrow the brow, the eyes are closed slightly by the *obicularis oculi, platysma* draw the lips downwards, *mentalis* pull the lips downwards and the lips are pursed by the *orbicularis oris* (Gray, 1918/2000).

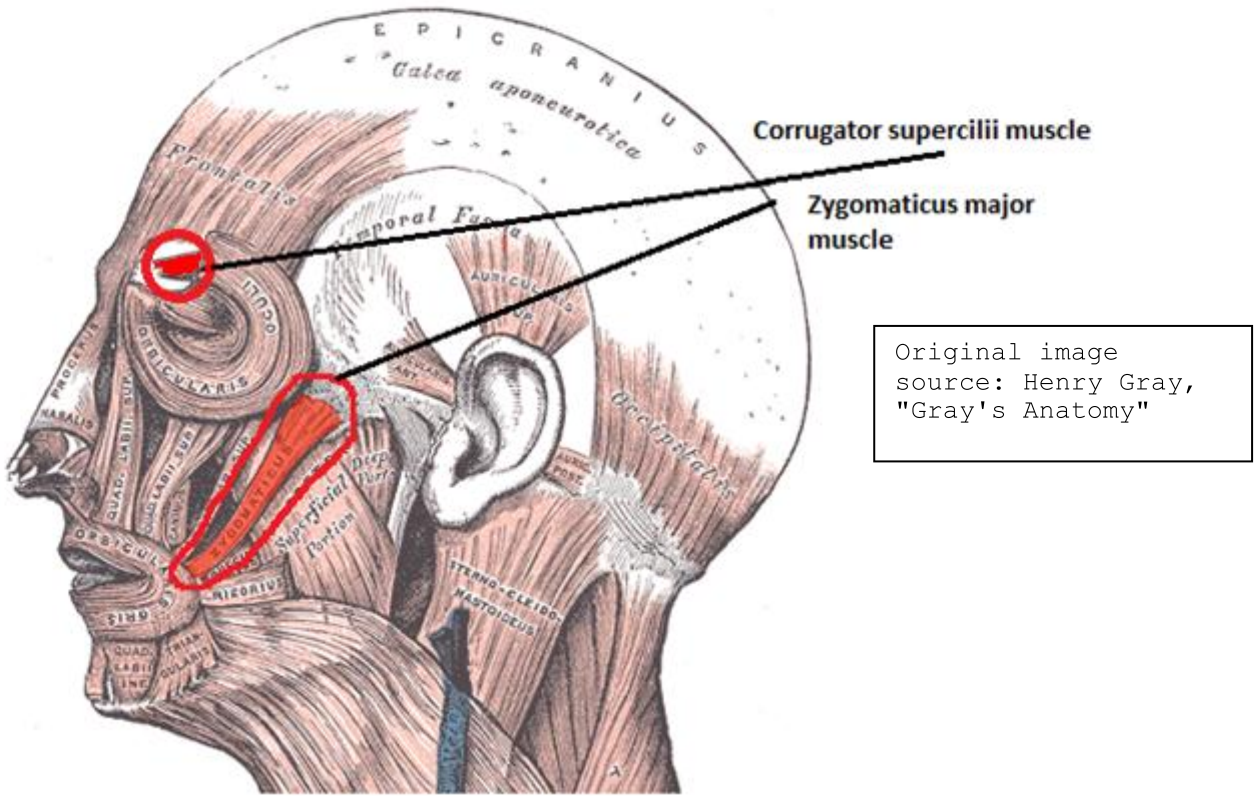

Figure 8. Muscles of the face. The zygomaticus major draws the angle of the mouth backward and upward as a smile. The corrugator supercilii draws the eyebrow downward, furrowing the brow in a frown. (Zygomaticus major & Corrugator supercilii are both highlighted in red; image adapted from Gray's Anatomy: Imaged retrieved from http://www.utsc.utoronto.ca/~psyb10/images/Zygomaticus.png)

In studies measuring emotions, researchers have used two muscles extensively; the zygomaticus major as a measure of positive emotions and the corrugator supercilii as a measure of negative emotions (see Figure 8). These muscles have been used in past research as an indication of how people mimic the facial expressions of others (Dimberg, 1982; Dimberg & Petterson, 2000; Dimberg & Thunberg, 1998; Dimberg et al., 2000), and to show that fear relevant stimuli automatically produce facial expressions (Dimberg, 1986), but more relevant to the current study, as a direct measure of affect in a variety of studies (Seamon, McKenna, & Binder, 1998; Winkielman & Cacioppo, 2001; Winkielman et al., 2006). Researchers have chosen these muscles due to the activity of these muscles being mutually exclusive. For example, using the oculi muscle (eye sphincter) would be a poor choice for differentiating between smiles and frowns as this muscle is activated in both expressions.

The frequency components of a raw EMG signal related to muscle activity typically range from a few hertz (Hz) to 5000Hz approximately (Clancy et al., 2002; Fridlund & Cacioppo, 1986). The most reliable components of this signal occur between 10Hz and 200Hz (Hayes, 1960; van Boxtel, Groundswaard, & Schomaker, 1984) and activity over 30Hz relates to the aggregated activity of motor unit action potentials (Basmajian, Gopal, & Ghista, 1985). The activity of the facial muscles only represents a small proportion of the total EMG signal recorded. Other energy within the signal is a result of noise. Many authors have defined noise as simply any unwanted signal (Tassinary, et al., 2007). These unwanted signals can come from biological origins (e.g. activity of adjacent muscles) or from non-biological origins (e.g. supply frequency interference or power line noise). Unwanted signals are often present in frequency ranges that can be weakened by using filtering techniques (although some sources including muscle crosstalk exist in the entire frequency range of the desired signal and cannot be removed in this way). Low frequency noise, relating to electrode movement or electrode wires can be weakened using a high pass filter (Clancy et al., 2002). High frequency noise may be the result of radio frequency interference from, for example, computer equipment. A low pass filter will remove this noise, and this filter should be set so that the cut off frequency is at the maximum range of the EMG signal (typically between 400 and 500Hz, van Boxtel, 2001).

The most problematic exogenous noise in the lab within an EMG recording is narrowband noise, as it comes from several sources and overlaps in frequency with the EMG signal (Tassinary, et al., 2007). For example in the UK, the mains electricity supply frequency is 50Hz and this frequency also contains energy relating to muscle activation. Due to the magnitude of this supply frequency interference, any energy at this frequency may be more related to the interference of this supply current than to muscle activity and is best removed (Tassinary, et al., 2007). This will result in a loss of muscle activity data at this frequency, but this is unavoidable with this method (Clancy, et al., 2002). For this study, to reduce the risk of interference from outside electrical sources, all trials were conducted in a Faraday cage.

An important factor in the capturing the EMG signal is the sampling rate. This refers to the frequency at which muscle activity is recorded from the target muscle site. If the sampling rate is too slow, this can result in the distorting of the signal, such as aliasing (Gitter & Stovlov, 1995). This occurs when the sampling rate is not sufficient to capture peaks within the high frequency components of the signal. When aliasing occurs, rather than recording the maximum extents of the peak, a submaximal component of the wave is recorded. This results in artificially low power within the high frequency components of the recording. To avoid aliasing, as well as other signal distortions, the sampling rate should be approximately twice the frequency of the maximum expected frequency of the signal (Clancy et al., 2002). This 2x rate is known as the Nyquist frequency. So for example, the facial EMG highest frequency component is 500Hz (Clancy et al., 2002), and therefore the sampling rate for recording should be a minimum of 1000Hz. There has been debate as to whether oversampling (i.e. over that of the Nyquist frequency) provides any benefit in recording EMG signals (reviewed in Ives & Wigglesworth, 2003), so for this reason the sampling rate in the current study is greater (2500HZ) than that of the traditional Nyquist frequency.

Raw EMG signals are pseudorandom signals of positive and negative peaks around an electrical zero point. As averaging this type of signal will yield a mean of 0, the signal must be converted into a useful form that may be described using quantitative statistical methods. The most common method used to overcome this issue is full wave rectification, where the negative peaks are converted into positive peaks and combined with the positive component of the existing waveform.

Once the EMG data have been collected and converted into a useable format that can be described using quantitative statistical methods, the data are then converted into standardised scores by expressing EMG response magnitudes as a proportion of an adequate baseline value (van Boxtel, 2010). EMG amplitudes are measured on a ratio scale, so expressing them as a proportion of baseline level is preferred to expressing them as difference scores between baseline and response levels (van Boxtel, 2010). This method of standardisation allows direct comparison of affective responses in different muscles within the same person. It also provides a solution to the problem that EMG amplitudes of an individual may vary considerably over repeated measurement sessions (Lapatk et al., 2010; van Boxtel, 2010).

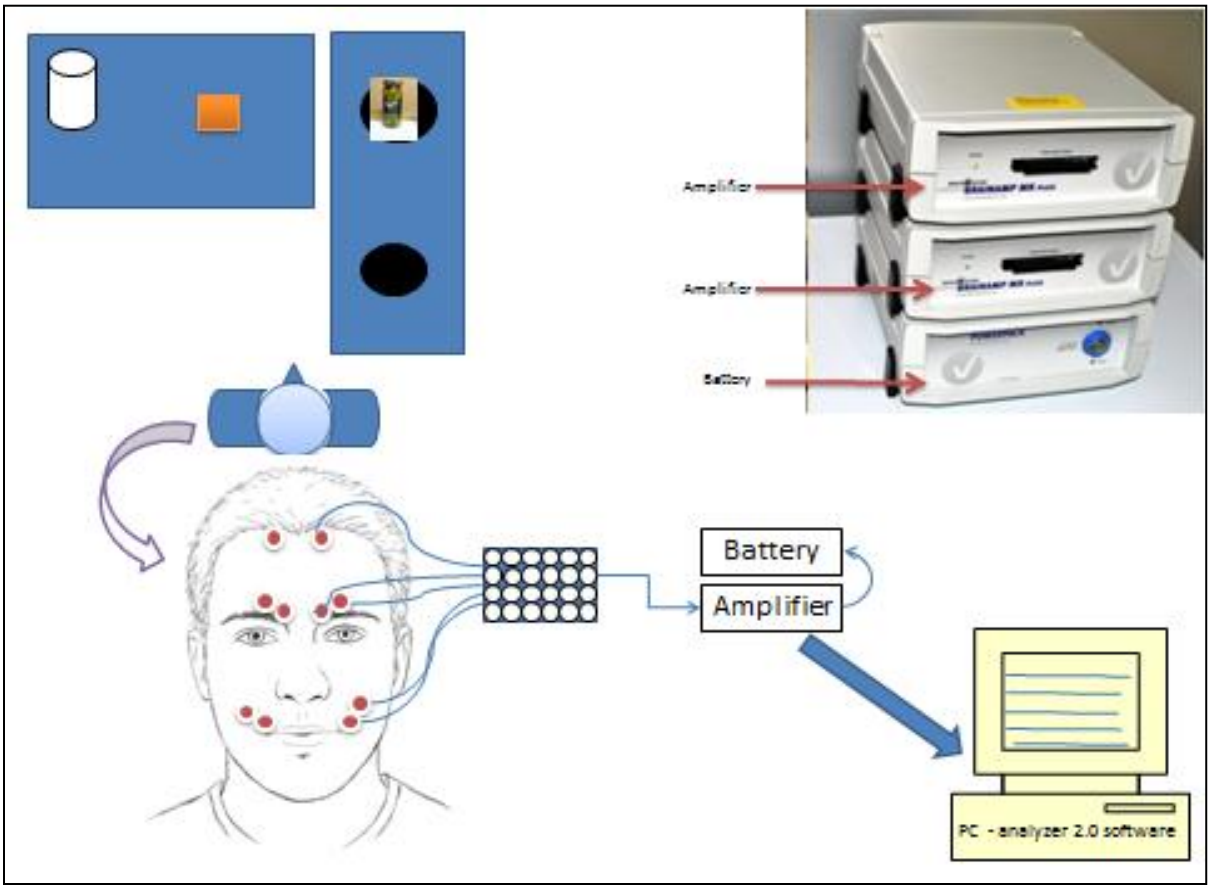

Figure 9. Electromyography equipment setup. BrainVision Analyzer collected the data and generated markers for data analysis.

Study 4 - Emotional Response to Imaged Motor Fluency: Evidence from Facial Electromyography

Self-reports are often used to assess affective processes. However, many psychophysiologists recognise that this method may be biased by such factors as social desirability concerns (e.g. Vanman, Paul, Ito, & Miller, 1997) or may be simply insensitive to the faint vicissitudes of affect (Öhman & Soares, 1994). Thus researchers have sought physiological measures that differentiate between pleasant and unpleasant states (Larsen, Norris, & Cacioppo, 2003). One such method, as noted above, is facial electromyography (fEMG). Within the research it has been found that affective feelings automatically trigger specific facial expressions involving different facial movements. fEMG is a non-invasive method that is sensitive enough to capture fleeting, subtle changes in facial muscles in an emotional process where visual observation is unavailable or ambiguous (Neta, Norris, & Whalen, 2009; Tassinary et al., 2007). Muscles that are of particular interest that discriminate the valence (pleasantness) and intensity of emotional states (Cacioppo et al., 1986) are the zygomaticus major (ZM) and corrugator supercilii (CS).

The ZM originates at the malar bone and inserts into the angle of the mouth. Contraction of the ZM results in pulling the lip corners back resulting in a smile (Gray, 1918/2000). The CS is at the inner extremity of the eyebrow. This muscle draws the brows together and downward, producing vertical furrows (i.e. a frown; Gray, 1918/2000).

It is well known that humans react to emotional facial expressions with specific congruent facial muscle activity (facial mimicry), which can be reliably measured by EMG (Dimberg, 1982; Larsen et al., 2003). For example, pictures of happy facial expressions increase ZM activity and decrease CS activity, while pictures of angry facial expressions evoke increased CS activity. These facial muscular reactions appear to be spontaneous and automatic (Dimberg & Thunberg, 1998).

EMG has also been used as a measure of emotional response in other affective tasks and not just mimicry. For example, using pleasant and unpleasant scenes Cacioppo et al. (1986) found that activity over the ZM was greater when pleasant scenes were presented than when unpleasant scenes were presented, whereas activity over the CS was greater when unpleasant scenes were presented than when pleasant scenes were presented.

EMG has also been used in measuring responses to imagery of pleasant or unpleasant stimuli. Studies have shown that activity in the ZM increases when individuals image pleasant thoughts and that activity in the CS increases when imaging unpleasant thoughts (Schwartz, Fair, Salt, Mandel, & Klerman, 1976; Schwartz, Ahern, & Brown, 1979; Schwartz, Brown, & Ahern, 1980). More recently, Hu and Wan (2003) observed patterns of facial EMG activity responses to self-generated emotions of happiness, anger, fear, sadness, disgust, and surprise. The results supported previous findings where imaged situations of happiness were associated with increased EMG power mainly at the ZM and imaged situations of sadness were associated with increased EMG power mainly at the CS (Brown & Schwartz, 1980).

It is not surprising that emotional responses, as reflected by facial EMG, are similar whether the stimuli are experienced visually or are simply imagined. Brain mapping techniques indicate that actual task performance and mental simulation share common neural substrates, although cerebral networks do not fully overlap (Decety et al., 1994; Lotze & Halsband, 2006; Roland, Larsen, Lassen, & Skinhoj, 1980; Stefan, Fink et al., 1995). Moreover, transcranial magnetic stimulation studies showed an increase in corticomotor excitability during motor imagery that is both muscle specific and temporally correlated to that observed during actual execution (Hashimoto & Rothwell, 1999; Stinear, & Byblow, 2003). Such data support the principle of functional equivalence between imagined and actual movement. It might be expected then that mental imagery of valenced stimuli would produce a similar emotional response and facial EMG pattern as occurs when directly experiencing the stimuli.

In most facial EMG studies, the stimuli are overtly emotional (e.g. facial expressions, emotional pictures, imagery of emotional thoughts). However, the technique has also been used to test emotional responses to the dynamics of cognitive processes. For example, studies of perceptual fluency have found that when perceptual processes are more fluent, positive emotion is evoked, even when the stimuli being processed are not overtly emotional. The facial EMG technique has been used to test whether such emotional responses to fluent perception occur spontaneously. Winkielman and Cacioppo (2001) used EMG to measure affective responses to a series of neutral pictures (line drawings of neutral objects e.g., airplane, horse, dog, house) while processing ease was unobtrusively manipulated. The results indicated that high fluency (easier to process pictures) was associated with stronger activity over the ZM (indicative of positive affect) whereas it was not associated with activity over the CS (indicative of negative affect). This indicated an affective response to processing fluency for non-emotive stimuli.

Cannon et al. (2010) extended the fluency hypothesis to the motor system. They tested whether positive affect associated with motor fluency arises spontaneously, when feelings about the objects of the interactions are not consciously attended to. Participants viewed images of items and indicated via key press whether the items were kitchen or garage items. All items were graspable items and in half the trials the handle in the image was orientated to the hand that corresponded to the correct key press. Stimuli were also presented laterally on the computer monitor. In the grasp-compatible condition (handle oriented toward the hand of the correct key press), the stimulus was also presented on the side of the screen corresponding to the correct key press. In the grasp-incompatible condition, the stimulus appeared on the side opposite to the correct key press. Hence response compatibility was determined by spatial stimulus-response compatibility (i.e. the Simon effect; Simon & Small, 1969), as well as grasp affordance (Tucker & Ellis, 1998). Results indicated that items in the compatible condition resulted in faster key press and more activity in the ZM indicating a positive affective response to motor fluency, even when participants were not attending to their emotions.

The current study will attempt to extend the findings of Study 2.1, which found that when participants in the movement imagery group (MIG) imaged moving the items in either a fluent or non-fluent manner, higher affective ratings were reported for the objects associated with the fluent action condition. However, in that study, in order to measure emotion the participants were asked to give an affective rating for the item after they had imaged moving it. This results in participants explicitly attending to their emotional responses, which may itself influence the affective ratings reported. By using fEMG, Study 4 tests whether imaged motor fluency evokes emotion if the task does not require attending to emotional states.

One difference between this study and Study 2.1 is that Study 2.1 included the use of a control group (static imagery group- SIG), but this study will not. The control group was included in Study 2.1 to test whether just the visual difference between the fluent and the non-fluent conditions were creating the affective response in MIG. For SIG, the effect was in the opposite direction to MIG, however this was not a significant main effect (p = .256). This means that the results of the movement imagery group (MIG) in Study 2.1 cannot be accounted for by differences in the visual scene alone. Consequently, the present study will not include a static imagery control group. Given the demands of EMG recording, it was difficult to justify repeating this condition, since Study 2.1 effectively ruled out differences in visual appearance of the fluent and non-fluent conditions as a confounding variable. If visual aspects of the fluency conditions do contribute to the emotion effects, based on the results of

Study 2.1, they would be expected to operate in the opposite direction to the fluency effects driven by motor imagery.

Method

Participants

A total of 32 undergraduates from Bangor University volunteered to take part in this study, and received course credit for their participation. Right-handed participants under the age of 30 were required for the study; 3 left-handed people and 2 people over 30 years old participated for educational purposes, but their data were not analysed. Thus, 27 participants (10 male/17 female; mean age 19.5 years, 1.80 SD) were included in the study. Institution ethics was obtained and all participants gave informed consent. All participants were debriefed in full as to the nature of the study at the end of the study.

Stimuli

As in the previous studies of the thesis, a total of 20 stimuli were used, consisting of 5 pairs of household items (2 x tins corned beef, 2 x washing up liquid, 2 x jarred olives, 2 x staplers of different colour, 2 x shampoo) and 5 pairs of abstract block items (2 wooden blocks in each pair, matching in shape but of different colour). The household stimuli chosen were non-familiar brands to reduce any pre-existing associations with the stimuli.

Apparatus

As in the previous studies, participants were seated at a table that had two platforms on it (see Appendix 1). The platform to the participant’s right was 55 x 24.4 cm and on this platform there were two pressure sensitive circular plates, aligned one in front of the other with respect to the participants' position. Both plates had a diameter of 6 cm. The plate (P1) closest to the participant was positioned 11.1 cm from the bottom of the platform to the centre of the plate and 12.4 cm from the side of the platform to the centre of the plate. The second plate (P2) was 45.6 cm from the bottom of the platform (34.5 cm directly beyond P1) and again 12.4 cm from the edge of the platform.

The platform on the participant's left was 18 x 28.7 x 7.7 cm. A small yellow square (2 x 2.5cm) was positioned on the platform slightly off centre (11.9 cm from the right edge and 15 cm from the left edge) and was 7.8 cm from the top of the platform and 7.8 cm from the bottom.

Task

During the imagery task, participants sat at a table with their hands in their lap. They imaged that their right hand was resting on P1. Participants imaged lifting their hand from P1, reaching out and grasping the stimulus item resting on P2, picking up the stimulus item and moving it to the target (yellow square) on the destination platform, placing the item down on the target and finally returning their hand to P1.

Fluent vs. Non-Fluent conditions

As in the previous studies, the participants imaged interacting with the stimuli in one of two ways during the imagery task; in either a fluent manner (movement with no barriers or obstacles that must be avoided) or a non-fluent manner (a barrier or obstacle must be avoided). The barrier used was a vase of water that was placed on either the right hand side of the destination point, thus acting as an obstacle (non-fluent condition), or that was placed on the left hand side of the destination point so that it in no way created an obstacle to be avoided (fluent condition).

Trial Condition and Order

Consistent with the previous studies, for each participant, one item from each stimulus pair was randomly assigned to the fluent condition and the other assigned to the non-fluent condition. This meant that each test (i.e. complete set of trials) was comprised of a total of 10 fluent trials and 10 non-fluent trials. Each test also had a mirror test, which was completed by a different participant and had the opposite fluent and non-fluent mappings for the stimulus items, with items presented in the same order. This meant that across the entire group of tests each item appeared equally often in the fluent and non-fluent condition. The presentation order for the 20 stimulus items was randomly generated for each pair of mirrored tests, but there were constraints; two items of the same pair could not appear directly one after the other, and no more than four trials in the same condition (fluent or non-fluent) could occur in a row.

Imagery Modalities

For the present study, participants were required to image the action using a combination of internal visual imagery (IVI), which is visual imagery experienced from the first-person perspective, and kinaesthetic imagery (KIN), the feeling of the movement. These modalities were chosen based on the findings from Study 3. Those results indicated that fluency of the imaged action influenced affective ratings only in groups using kinaesthetic imagery, and overall affective ratings (not the fluency effect) were higher when KIN and IVI were combined, compared to when KIN was used alone. Although the fluency effect was no greater in the combined group compared to the KIN alone group, the higher overall ratings might indicate that it was easier to combine the two modalities than to use KIN alone, which might make it easier for the participants to do the task.

Viewing and Imagery Durations

Previous research has indicated that duration of viewing time can have an effect on liking ratings, specifically that longer viewing times can increase liking ratings (Reber, et al., 1998, Willems & Van der Linden, 2006). In this study, viewing time was controlled with the use of a light. The participants were seated in a dark room. For each trial, the experimenter pressed a key to start the trial (designated in the EMG data file as Marker 1), and after 1000ms there was a warning tone for the participants (Marker 2); 200ms after the tone a light came on (Marker 3) to allow the participants to see the stimulus. The light remained on for a duration of 2500ms (Previewing stimulus duration), the light then went off (Marker 4) and the participant began imaging the action. The participant had 4000ms to image the action (Imaging action duration). After this time had lapsed the participants heard another tone (Marker 5), followed 200ms later by the light going on (Marker 6). The light remained on for 3000ms (Postviewing stimulus duration; participants were informed that this time period marked the end of the task before moving onto the next trial, and the participants were not given any instruction what to do in this time period) before going off again (Marker 7) to signal the end of the trial (see Figure 10 for schematic).

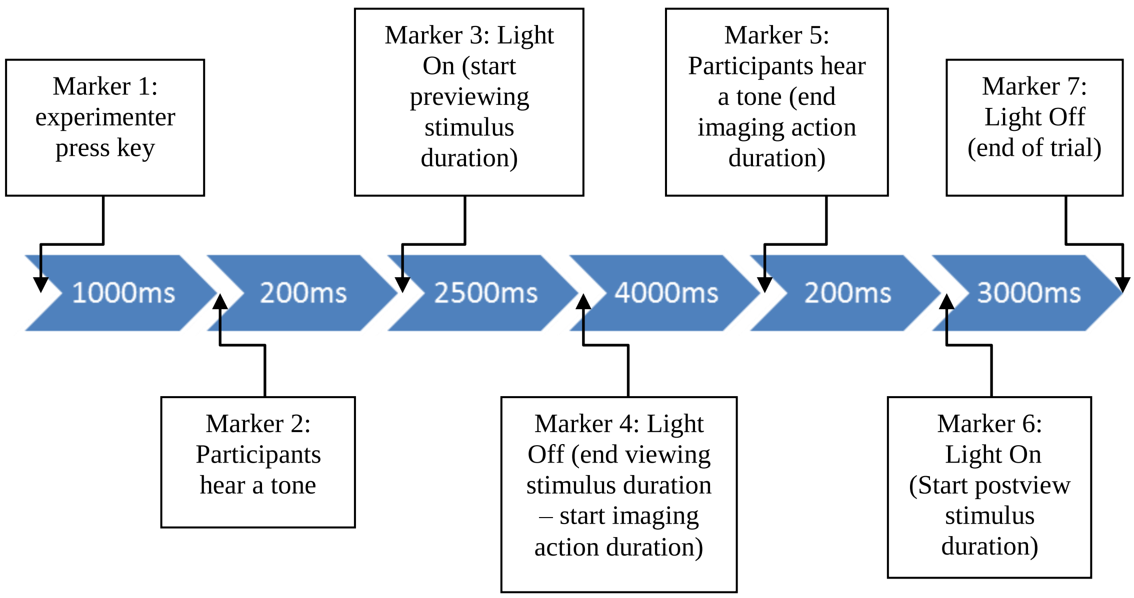

Figure 10. Schematic representation of the timeline involved in the performing each trial. Note that durations are not drawn to scale

Measures

Vividness of movement imagery questionnaire-2 (VMIQ-2: Roberts et al., 2008): The VMIQ-2 is a revision of the Vividness of Movement Imagery Questionnaire (VMIQ: Isaac et al., 1986) and comprises 12 items that assess the ability to image a variety of movements, such as walking, riding a bike, swinging on a rope. Participants are required to image each item in three ways: using external visual imagery; internal visual imagery; and kinaesthetic imagery, and rate the vividness on a five-point likert scale from 1 (perfectly clear and vivid) to 5 (no image at all). The VMIQ-2 has demonstrated acceptable factorial validity, construct validity and concurrent validity (see Roberts et al., 2008). For the purpose of the present study, the VMIQ-2 was used as a means of assessing imagery ability and visual imagery perspective (internal or external) preference of the participants.

Post-Experimental Questionnaire: After completion of the imagery task, each participant filled out a post-experimental questionnaire (see Appendix 9) asking them about their imagery usage in the task, as well as their best guess about the research question that was being addressed. This was to ensure that the participants adhered to the imagery modality that was assigned, and also to ensure that the participants were naïve to the actual purpose of the study. Participants were asked to indicate on a likert scale ranging from 0 (no visual imagery use) to 10 (high visual imagery use) the degree to which they felt that they used visual imagery. Data from any participant scoring ≤ 2 were to be removed from the data set (0 participants were removed). The participants were asked to indicate on a likert scale from 0 (completely internal perspective) to 10 (completely external perspective) the visual perspective that they used to complete the task. Data from participants with ratings of ≥ 8 were to be excluded from the data set (0 participants were removed). And finally the degree to which they felt they used kinaesthetic imagery when performing a task was assessed.

Again on a likert scale from 0 (no kinaesthetic imagery use) to 10 (high kinaesthetic imagery use), participants indicated the degree to which they felt that they had used kinaesthetic imagery during the task. Data from participants with ratings of ≤ 2 were to be excluded from the data set (0 participants were removed). Finally, no participant guessed the aim of the study. As all participants adhered to the imagery conditions and were naive to the purpose of the study, data from all participants were included in the study.

The participants were also asked about which condition (fluent or non-fluent) they perceived to be more effortful and which condition they preferred to image. Participants were asked to answer the questions in the order that they appeared and not to go back on any question once it was answered. This was to prevent the participants from changing the answer to the question about research question being addressed, as completing subsequent questions regarding the difference in fluency may have influenced their answer regarding the nature of the research question.

Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006): This 39 item inventory measures the five facets of mindfulness; observing, describing, acting with awareness, non-judging of inner experience and non-reactivity to inner experience derived from a factor analysis of questions that measure trait-like general tendencies to be mindful in daily life. Items are rated on a likert scale ranging from 1 *(never or very rarely true)* to 5 *(very often or always true)*. The FFMQ has demonstrated good internal consistency (Baer, et al., 2006). This questionnaire was completed last, as part of a separate, larger study; data from this questionnaire will not be considered here.

Procedure

Participants were informed that they were taking part in a frontal lobe event related potential (ERP) study measuring electrical activity in the brain during an imagery task. This deception was necessary in order to control for conscious control of facial muscles. (At the end of the session, when the participants were debriefed, the true nature of the EMG measurements was explained.)

Upon arriving to take part in the experiment session, the participants received an information sheet and were informed that the nature of the study was measuring electrical activity in the brain during an imagery task. After written consent was acquired, the participants were seated at the table and fitted with the electrodes. Once the electrodes were fitted the participants completed the VMIQ-2, thus allowing time for the electrodes to settle to a baseline before the recording of the EMG activity.

Once the VMIQ-2 had been completed, the imagery task was explained to the participants, including the instructions to use internal visual imagery and kinaesthetic imagery when performing the image of the action. At no time when referring to the movements did the experimenter label them as easy / difficult, or fluent / non-fluent so as not to unduly influence the participant and their possible affective responses.

An imagery script identical to the one used in for the IVI/KIN group in Study 3 (see Appendix 5) was read to the participants. The imagery script was first read by the experimenter with the participants imaging the actions as they were read. The imagery script was then read by the participant and then the entire action imaged. The participants were instructed to image in real time.

Participants first completed 22 trials (2 practice trials to become familiar with the timing of the light, and 20 experimental trials). After those 22 trials, participants were given a short break of a minimum of 1 minute. During this time the participants were reminded to image performing the task as quickly and as accurately as possible and to image returning their hand to the starting plate at the end of each movement. They were also reminded to image using IVI and KIN imagery modalities and the modalities were explained to the participants to ensure understanding of the modalities. Participants then completed the same 22 imagery trials for a second time and after this completed the post-experimental questionnaire. After the electrodes were removed they completed the FFMQ-2. The participants were thanked for their participation in the study and were debriefed fully as to the nature of the study and the nature of the muscle sites being measured by the electrodes.

EMG Recording

Facial muscle activity was recorded from eight active electrodes corresponding to four distinct bipolar montages. The electrodes were placed on both the left and right sides of the face over the zygomaticus major (ZM), which is involved in smiling, and over the corrugator supercilii (CS), which is involved in frowning.

The arrangement of the electrodes followed standard guidelines (Fridlund & Cacioppo, 1986). Electrode sites were prepared by cleaning the site with alcohol to degrease the skin and rubbing electrode gel into the site (Fridlund & Cacioppo, 1986). Once all the electrodes were in place, participants completed the VMIQ-2, which allowed at least 15 minutes for the electrodes to settle to baseline. The data were continuously recorded at a sampling frequency 2500Hz.

Using BrainVision Analyzer version 2.0 (Brain Products GmbH), conventional bipolar montages were calculated from each of the electrode pairs for each muscle. This was done by subtracting the activity of one electrode placed over the muscle from the activity of the other electrode nearby (Achaibou, Pourtois, Schwartz, & Vuilleumier, 2008). The EMG signal was then filtered with a high pass filter of 20Hz (to account for low-frequency artifacts such as eye movements, eye blinks; van Boxtel, 2001, 2010), a low pass filter of 400Hz and a notch filter of 50Hz (to account for external power line interference; van Boxtel, 2010). The data were then segmented into 40 separate trials for each participant (practice trials were excluded), rectified and averaged over 100ms time windows.

The signal that was obtained after the raw data had been filtered and segmented was then reanalysed. For ZM, trials where the amplitude exceeded ±75μV were excluded from the data; for CM, amplitude that exceeded ±100μV for trials were excluded (Makin, Wilton, Pecchinenda, & Bertamini, 2012). This was done to avoid spurious outlier effects. Following Makin et al, a higher cutoff was chosen for CM because CM activity is typically greater than ZM. Outlier trials were removed across all muscle sites on both the left and right hand side of the face. Out of a total of 1200 trials completed by all participants 137 (11.42%) were removed. On further inspection of the data it was noted that the majority of the removed trials came from only a few participants. The data were re-examined on an individual participant basis. All participants completed 40 trials over 2 blocks, with 20 trials in each block. Any participant for whom 3 or more trials (out of a total of 5) were removed in one condition (i.e. abstract item/non-fluent; abstract item/fluent, etc.) in one block was excluded from the study. Also any individual that had 40% or more of trials removed were also excluded (this is max % that can be removed without exceeding more than 3 in one condition). This lead to the removal of 4 participants from the study who had more than 3 trials removed in one condition and/or exceeded 40% removed trials (37.5%, 85%, 40%, and 32.5%). The data were then re-examined for percentage of trials removed in different conditions. Out of a total of 1040 trials completed by the remaining 23 participants, 59 trials (5.7%) were removed. The percentage of trials removed in each condition did not differ (5.8% fluent abstract vs. 6.2% non-fluent abstract vs. 6.2% fluent household vs. 4.6% non-fluent household, p=.831), nor was there a significant overall difference in the amount of trials removed per block (5% block 1 vs. 6.5% block 2, p=.430).

Once all the outliers had been removed the data were then standardised. van Boxtel (2010) recommends that due to the fact that EMG amplitudes are measured on a ratio scale, then expressing EMG response magnitude as a proportion of an adequate baseline value is preferred to expressing them as a difference between a baseline and response level. In this case, the baseline amplitude for each trial was the average amplitude of the 500ms time period (i.e. the average of the 5 100ms time bins) prior to the 1st warning tone for the participants. To create the standardised score, the amplitude at each 100ms time bin following the 1st warning tone was divided by the baseline amplitude. Once standardised in this way, for each participant the average across trials was then calculated for each 100ms bin, separately for each combination of block, side, muscle, and condition (e.g. block 1, left, CS, abstract, non-fluent; block 1, left, CS, abstract, fluent, etc.). The data were exported for further analysis in SPSS.

Results

Imagery Ability

All participants reported scores of less than 49 on each of the VMIQ-2 subscales. A score of 49 corresponds to an average score per item of more than 4, indicating that participants were unable to image items on the respective subscale(s) (IVI, EVI, KIN). Participants also reported total scores of less than 108, which correspond to an average score of 3 on each of the respective subscales. Although participation in the study was not dependent on imagery ability, the results indicated that all participants reported an adequate ability to image.

Electromyography Results

The main aim of this study is to examine the whether imaged fluent and non-fluent motor actions will result in different emotional responses. Given the fact that ZM is associated with positive affect and CS is associated with negative affect, the effect of interest is a muscle x fluency condition interaction. The results section will therefore only report main affects for the muscle and fluency factors, and any muscle x fluency interactions or higher order interactions. Because there are a large number of factors in this study, significant effects that do not involve a muscle x fluency interaction will not be presented.

The fluency effects across 100ms time bins are presented in Figure 11, separately for each muscle. The data were broken down into 3 separate segments. The first was the preview segment where the participants saw the item and the position of the vase. The next was the imagery segment where the participants imaged performing the fluent and non-fluent actions. And finally the postview segment was when the participants saw the item for a second time, which indicated to the participants that the trial was coming to an end. The data for each of these segments was analysed separately. For the preview segment, the first 300ms was removed owing to the presence of a stimulus onset orientating peak described in previous research (Dimberg, et al., 2000). The first 300ms were discarded and analysis was carried out on data after the onset peak. To avoid the possibility of orientating affects (to the light going off and on again) in the imagery and postview segment, the first 300ms of these segments were also discarded.

Preview segment

For the preview segment, the muscle activity (dependent variable) was averaged across 22 100ms bins. A 2x2x2x2 (Side (left/right) x Muscle (ZM/ CS) x Item (Household/Abstract) x Fluency (Fluent/Non-fluent) fully repeated measures ANOVA was conducted on the data. The results indicated that there was a main effect for muscle (F (1, 21) = 12.137, p = .002, η^2 = .366, 1-β = .913), with a higher muscle activity for CS (1.176) than for ZM (0.992).

There was also a significant muscle x fluency interaction (F (1, 21) = 9.027, p =.007, η^2 = .301, 1-β = .817; see Figure 12). There were no higher order interactions involving muscle x fluency.

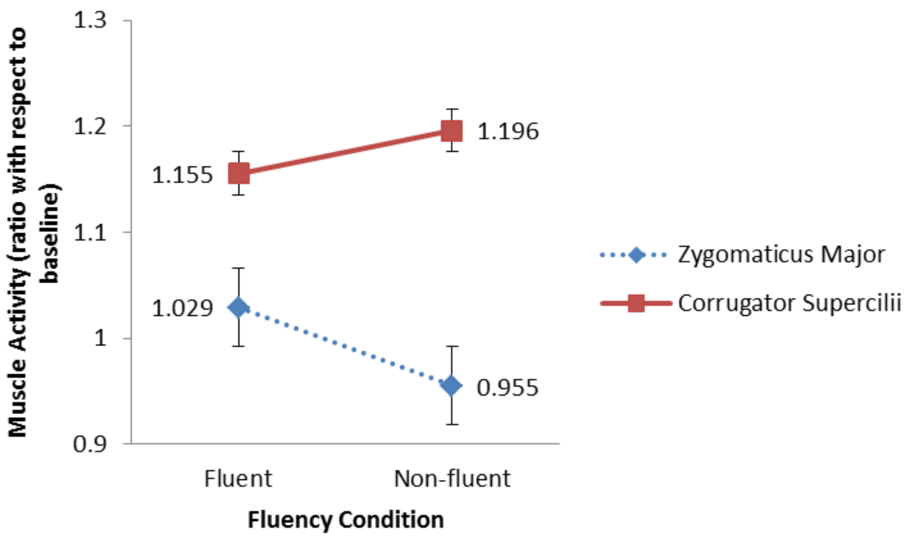

Figure 12. Muscle (ZM & CS) x Fluency (Non-fluent/Fluent) Interaction for preview segment. Muscle activity is expressed as a ratio with respect to the baseline activation.

Follow up analyses examining the two muscles separately revealed that for the CS, there was a main effect for fluency (F (1, 21) = 4.758, p =.041, η^2 = .185, 1-β = .548). Closer inspection of the cell means indicated that the CS was more active for the non-fluent condition (1.196) than for the fluent condition (1.155).

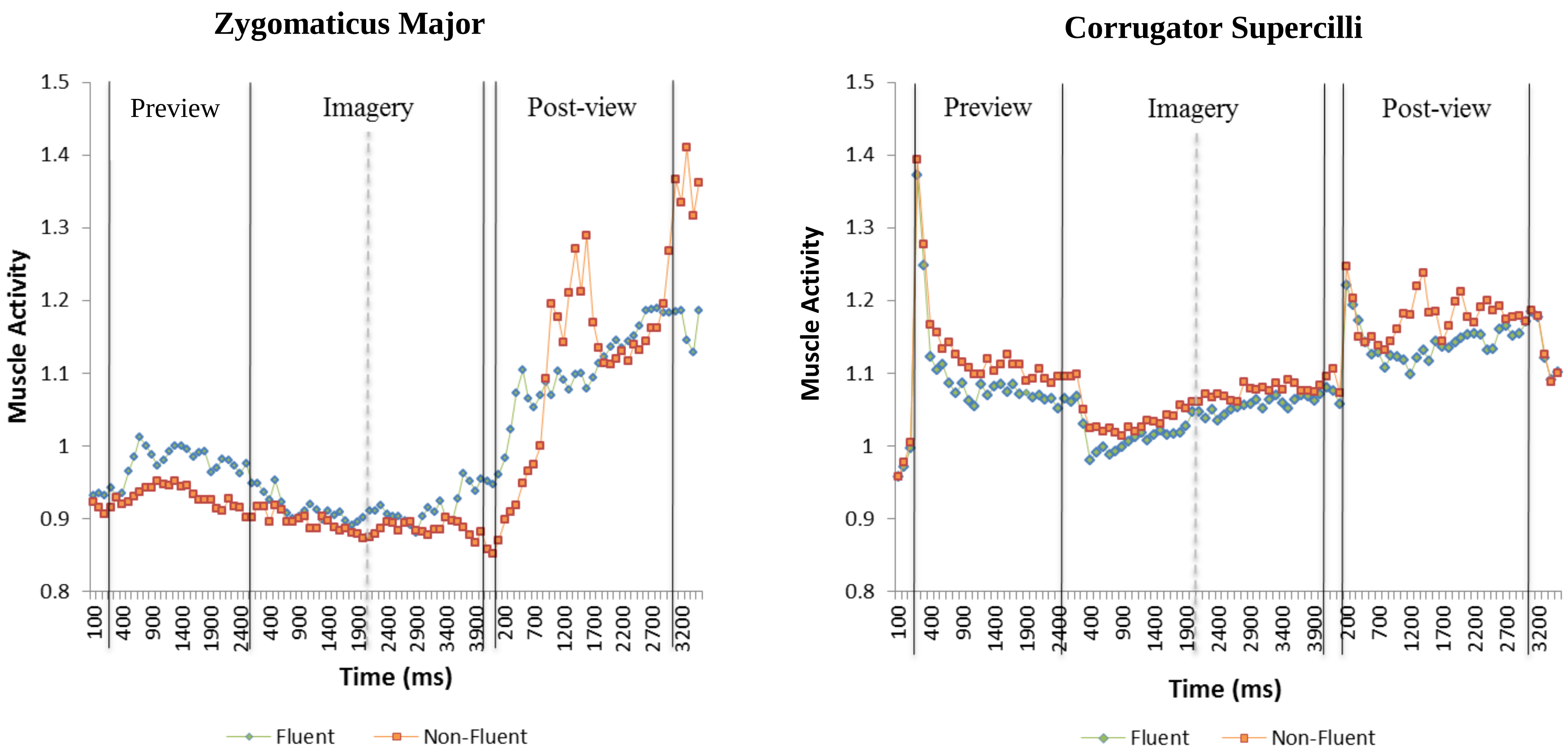

Figure 11. Fluency effects across time for corrugator supercilii and zygomaticus major.

For the ZM, results indicated that there was also a main effect for fluency (F (1, 21) = 7.263, p =.014, η^2 = .257, 1-β = .729). Closer inspection of the cell means indicated that the ZM was more active for the fluent condition (1.029) than for the non-fluent condition (.955).

Imagery segment

The imagery segment was divided into two time windows of 1800ms each, and the average muscle activity was calculated for each condition separately for both time windows. The decision to use two time windows was based on results from a similar study where participants performed the action, and the time taken to complete the actions was recorded. For fluent action, the average time it took to complete was 1949ms. Since motor imagery has been shown to have similar temporal characteristics to actual action (Decety, Jeannerod, Prablanc, 1989), it might be expected that most participants would be finished imaging after approximately 2 seconds, and any emotion effects might therefore differ between the first half of the time period and the second.

A 2x2x2x2x2 (Side (left/right) x Muscle (CS/ZM) x Item (Abstract/Household) x Fluency (non-fluent/fluent) x Time Window (window 1/window 2)) fully repeated measures ANOVA was conducted on the data. The results indicated that there was a main effect for muscle (F (1, 21) = 6.472, p = .019, η^2 = .236, 1-β = .680) with more activity seen across the CS (1.139) than the ZM (.988). There was also a 4 way interaction for side x muscle x fluency x time window (F (1, 21) = 11.291, p = .003, η^2 = .350, 1-β = .893) as well as a 4 way interaction for muscle x item x fluency x time window (F (1, 21) = 5.311, p = .032, η^2 = .202, 1-β = .594). There were no other significant interactions that involved muscle and fluency.

For follow up analysis, the data were firstly broken down by time window. Time window 1 results indicated that there was a significant main effect for muscle (F (1, 21) = 4.922, p = .038, η^2 = .190, 1-β = .562), with more activity across the CS site (1.127) than across the ZM site (.991). There were no further main effects or interactions for time window 1. For time window 2, results indicated that there was a main effect for muscle (F (1, 21) = 7.497, p = .012, η^2 = .263, 1-β=.743), with more activity across the CS muscle site (1.152) than the ZM muscle site (.986). Results also indicated that there was a 3 way interaction for side x muscle x fluency (F (1, 21) = 5.317, p = .031, η^2 = .202, 1-β = .595). The interaction was further broken down by side. For the left side of the face, there was a main effect for muscle (F (1, 21) = 7.166, p = .014, η^2 = .254, 1-β=.723) with more activity across the CS muscle site (1.123) than across the ZM muscle site (.979). For time window 2 on the right side, there was a main effect for muscle (F (1, 21) = 6.880, p = .016, η^2 = .247, 1-β=.706) with more activity across the CS muscle site (1.182) than across the ZM muscle site (.994). There was also a significant muscle x fluency interaction (F (1, 21) = 4.836, p = .039, η^2 = .187, 1-β = .555; see Figure 13). This interaction was further broken down by muscle type. In the CS there was no main effect for fluency (F (1, 21) = .354, p = .558, η^2 = .017, 1-β = .088). For the ZM there was a significant main effect for fluency (F (1, 21) = 4.963, p = .037, η^2 = .191, 1-β = .566), with activity higher for fluent actions (1.01) than for non-fluent actions (.97).

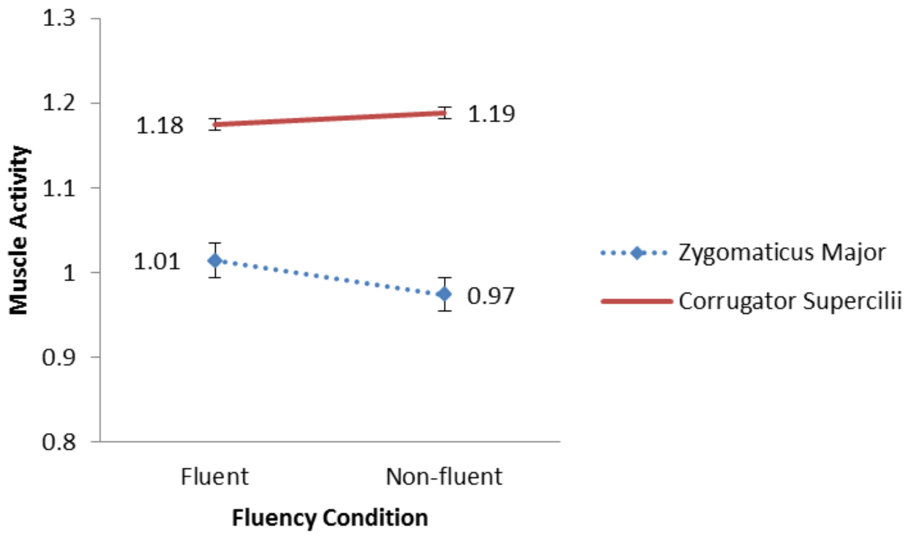

Figure 13: Muscle (CS & ZM) x Fluency (Non-fluent/Fluent) Interaction for imagery segment, right side, time window 2. Muscle activity is expressed as a ratio with respect to the baseline activation.

Postview segment

The postview was divided into two time windows of 1300ms each and the average muscle activity was calculated for each condition for both time windows. Two time windows were used because it was anticipated that since the postview segment indicated the end of the participant's task, participants might briefly attend to the stimulus but that attention was likely to wander during the second half of the segment. A 2x2x2x2x2 (Side (left/right) x Muscle (CS/ZM) x Item (Household/Abstract) x Fluency (non-fluent/fluent) x Time Window (window 1/window 2)) fully repeated measures ANOVA was conducted on the data. Results showed that there was a muscle x fluency interaction (F (1, 21) = 10.033, p =.005, η^2 = .323, 1-β = .855; see Figure 14).

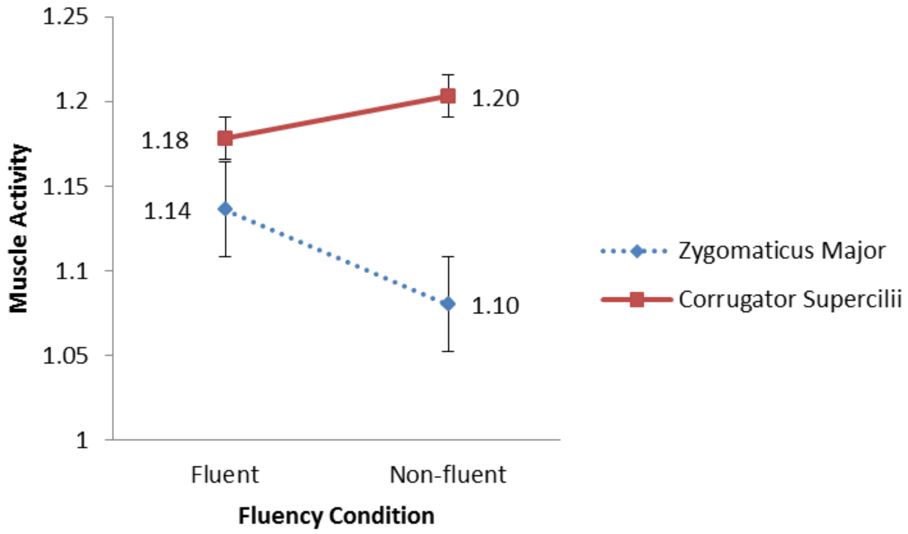

Figure 14. Muscle (CS & ZM) x Fluency (Non-fluent/Fluent) interaction for postview segment, right side. Muscle activation is expressed as a ratio with respect to baseline activation.

The data were examined for each muscle separately. For CS, there were no main effects or interactions for muscle or fluency. For ZM, there was a significant side x fluency interaction (F (1, 21) = 6.497, p =.019, η^2 = .236, 1-β = .681). When side was examined individually, there were no significant main effects or interactions for the left side. For the right side there was a main effect for fluency (F (1, 21) = 4.679, p =.042, η^2 = .182, 1-β = .541), with the ZM being more active for fluent actions (1.16) than for non-fluent actions (1.09).

Effort and Preference for Fluency Conditions

Following the imagery task, participants were asked about the action that they perceive to be more effortful for the trials they had just completed. They were asked to indicate which condition they felt was more effortful; the fluent action or the non-fluent action. An 11 point likert scale was used ranging from 0 *(fluent action was more effortful)* to 10 *(non-fluent action was more effortful)* with a further anchor at 5 *(equal effort)*. Results of a one-sample t-test against the value 5 indicated that for effort, participants found that the non-fluent condition was more effortful (mean = 7.5; t (21) = 4.103, p = .001).

The participants were also asked to indicate their preference for one of the fluency conditions on an 11 point likert scale was used ranging from 0 *(prefer fluent action)* to 10 *(prefer non-fluent action)* with a further anchor at 5 *(no preference)*. Results of a one-sample t-test against the value 5 indicated that the fluent action was preferred (mean = 3.43; t (22) = -2.598, p = .016).

Discussion

The main aim of the present study was to investigate whether imaged motor fluency will evoke an emotional response even when the participants are not attending to their emotional states. Visual inspection of the results indicated that for all three segments, preview, imagery, and postview, ZM tends to be more active when imaging actions that are more fluent (see Figure 11), whereas CS tends to be more active when imaging actions that are more non-fluent (see Figure 11). Although visual inspection of the data lends support to previous research associating ZM (positive emotion) with fluency, and CS (negative emotion) with non-fluency (Winkielman & Cacioppo, 2001; Cannon, et al., 2010), the statistical analyses of the data strongly support this fluency-emotion link only for the preview segment. For the imagery and postview segments, the statistical results are supportive but more limited. A fuller interpretation of the statistical inspection of the data is presented below, separately for the three segments.

Preview Segment:

During the preview period ZM muscle activity was greater for the fluent condition, whereas CS was greater for the non-fluent condition. This is in keeping with previous research that associates fluency with ZM and positive affect and non-fluency with CS and negative affect (Winkielman & Cacioppo, 2001). This result was predicted, but it is interesting that this segment shows the strongest effect, stronger than when actually imaging the action. Past research lends support for why an effect may be seen during the preview stage of the task.

During the preview segment of the task, participants had the chance to see the item that they were to image moving and the manner in which they were to image moving it (i.e. fluent / non-fluent). Evidence suggests that when an item is perceived in our environment this automatically activates the motor plans for interacting with the object (Rieger, 2004, 2007; Tucker & Ellis, 1998) even if there is no intention to act. With this motor planning, information may be processed about how easy or difficult the interaction with the stimuli may be (e.g. Ping et al, 2009; Vrana & van den Bergh, 1995). In this way our preference judgements for stimuli encountered on an everyday basis may be informed by the motor system as it plans an action. Ping et al., examined whether preferences for objects can be driven by how easy it is to act on them. Participants were presented with two items (one in an easy to grasp orientation and the other in a hard to grasp orientation) and asked to move their preferred item to another spatial location. Results indicated a preference for the item that was comparatively easy to grasp (i.e. handle pointed towards the participant rather than away), demonstrating that during the period prior to reaching for a stimulus, preference is influenced by the motor ease or difficulty of grasping the object. Hence emotional responses to stimuli are influenced by the ease or difficulty of planning actions.

In the present case, the participants knew that they would have to "interact" with the object by imaging a fluent or non-fluent action, and planning the imaged action presumably occurs during the preview period. Based on the results of Ping and colleagues, this perception and planning stage can give rise to information about the ease or difficulty of the interaction with the item (in this case whether the imaged motor action is fluent or non-fluent), causing the level of motor fluency to impact the appraisal of the item.

Previous research, then, supports the interpretation that motor processes trigger the emotion associated with fluency. An alternative account of the results, however, is that the visual system may be eliciting the emotional response, not the motor system. That is the emotional response may stem from simply the viewing of the scene, which differs for fluent and non-fluent conditions (the vase is to the left or right, respectively, of the yellow target square), and not from motor processing of the action. However, based on the results of Study 2.1, it is unlikely the results of this study are due to the visual scene alone. Study 2.1 incorporated the use of a control group (static imagery group – SIG) who were instructed to image the scene as it appeared in front of them with no movement whatsoever. Results showed no main effect for fluency ($p=.256$) with this group, but the result was in the opposite direction to the results in the current study. Results of Study 2.1 showed that for the static imagery group (acting as a control group), there was a higher affective rating for the non-fluent condition than for the fluent condition. Therefore if the results of the present study were to be explained by the visual scene and not the motor fluency, it would be expected that the results would be null or the opposite of what was found here (i.e. ZM activity would be higher for non-fluent imaged actions and CS would be higher for fluent imaged actions). As the results of this study follow the results of the movement imagery group (MIG) of Study 2.1, it is more likely that feedback from the action itself is causing the difference in appraisal of the valence of the task.

Imagery Segment:

A significant effect for fluency was observed in the imagery segment of the task, however, it was only observed in the ZM, only in time window two and only on the right side of the face. This provides some evidence for an effect of motor fluency on emotion during motor imagery, however the limited nature of the results must be considered.

While there is some evidence that imaged fluent actions resulted in higher ZM activity than non-fluent imaged action, there is no evidence at all that CS was affected by fluency. This lack of result for CS was not predicted, but it is not entirely surprising. Previous investigations that have used EMG to investigate motor fluency (Cannon, et al., 2010) and perceptual fluency (Harmon-Jones & Allen, 2001; Winkielman Cacioppo, 2001; Winkielman, Halberstadt, Fazenderio, & Catty, 2006) found the same result: fluency influenced activity of ZM but not the activity of the CS. The results were interpreted by Winkielman and Cacioppo as supporting the view that positive and negative affect may be subserved by separate systems, and as an indication that perceptual fluency selectively acts on the positive affect system (the hedonic fluency theory). Nonetheless, observation of Figure 11 promotes caution. There is a trend in the predicted direction for CS muscle activity across both time windows. This trend of data for CS activity being greater for non-fluent tasks is in line with the findings of Topolinski, Likowski, Weyers, & Strack, (2009) and Cannon et al. (2010), who found trends for an effect of fluency in CS. Whether effects of imaged motor fluency can be detected in both ZM and CS remains an open question. Further work that requires participants to engage in more complex and effortful processing might detect CS effects.

The effect of fluency on ZM activity during the imagery segment was only found for time window two. It had been expected that a stronger effect might occur during time window 1, because it was thought that the motor imagery was likely to be completed during time window 1. However, this alternative result could be due to the length of time given to complete the imagery. Results from a previous study indicated that on average it takes 1949ms to complete the actual action in these trials, and research indicates that time to complete a task and image the same task is similar (Decety et al., 1989). In this study, the participants were allowed 4 seconds to complete the tasks. Given this, it is hard to pinpoint where they were actually imaging the task and the time it took. Some participants may have imaged the actions as quickly as possible and completed in window 1, whereas others, despite being told to image in real time may have used the whole 4 seconds, or may have delayed the start time. It is probably safe to assume, however, that for all participants the action was completed by some point in time window 2.

A second reason why the fluency effect is only seen in time window 2 might best be explained by appraisal theory. Appraisal theory proposes that many different types of appraisals of a situation contribute to the overall emotional response (see Aronson, Wilson, & Akert, 2005 for a review). Appraisal dimensions include an assessment of novelty, an assessment of intrinsic valence (positive or negative feeling toward a stimulus or event), whether goals are being met by the event or stimulus, and assessment of one's ability to handle the event or stimulus. Time window 1 may include more appraisal dimensions than either the preview segment or time window 2 of the imagery segment. Within the preview segment, the goal was to encode the motor programme that was associated with the actions, and participants may only have concentrated on the part of the imaged motor action that focuses on the movement of the stimuli from platform to target, as this is the portion of the action that most varies in different trials. This may give rise to information about the fluent / non-fluent nature of the action, and would be appraised at the valence level of appraisal (perceived pleasantness or unpleasantness of the stimuli or event). For the imagery segment the goals have now changed from planning and encoding the action to completing the action as whole. The participants now have to incorporate all other elements of the imagery script to image a complete action. This may incorporate more levels of appraisal such as the degree of compliance with the task (recalling all elements of the script), compliance with the modality instruction (using IVI and KIN), imagining as closely as possible to real time, as well imaging performing the action as accurately as possible. All of these evaluations will add more dimensions to the task and if emotion is thought of as a continuous process, it may change as more appraisals are added or revised. Most of these evaluations do not differ greatly between the fluent and non-fluent conditions, and, indeed, much of the action itself is similar in the two fluency conditions (e.g. the reach for the item, the grasp, returning the hand to the start position.) As a result, the differences in emotional response that do link to the fluency condition may not be as detectable as they are during the Preview period when the fluency condition is being encoded, and goals and motor plans are primarily focused on the fluent/non-fluent distinction.

It is not entirely clear why the emotional fluency effect would become stronger during the second half of the imagery period. However, Cannon et al (2010) reported that fEMG measures of emotion grew stronger following the completion of a fluent or non-fluent action, and persisted for at least 1200ms at which point recording ended. They suggested that this increase of fluency-related emotion may be due to a reappraisal of the action. Perhaps in the current study, as the time moves out of window 1 and into window 2 and the imaging of the action is coming to an end, then many of the appraisal dimensions may drop away and the reappraisal of the action may focus largely on the aspects that were initially encoded during the preview preparation period, causing the emotional responses associated with the fluency conditions to re-emerge. This discussion is of course speculative, but it highlights some appraisals that might be occurring and influencing the emotional response during the imagery task, and which could in future studies be manipulated or controlled.

For the imagery and postview segments, the results of the fEMG were only evident on the right side of the face. In previous fEMG studies, muscle activity is generally recorded on the left side of the face as this side of the face tends to show higher activation levels than the right (Dimberg & Petterson, 2000). However results of previous studies in expression asymmetry and/or hemispheric activation were not consistent. Some studies indicated that there was more activity on the left side of the face than the right (indicating right brain dominance; e.g., Borod & Koff, 1990;

Ekman, Hager, & Friesen, 1981; Sackheim, Gur, & Saucy, 1978). Other studies have found the opposite with more activity on the right side of the face than the left (indicating left brain dominance; e.g., Sirota & Schwartz, 1982). Some studies have indicated that there may be a differentiation between positive and negative emotions (e.g., Davidson, 1993; Schwartz et al., 1979). At least two different hypotheses have been proposed (for a review, see, e.g., Camras, Holland, & Patterson, 1993; Fridlund, 1988). First, according to the right hemisphere hypothesis, the right hemisphere dominates the mediation of emotion and, therefore, facial expressions should be more intense on the left side of the face. Second, according to the valence hypothesis, the left hemisphere is the seat of positive emotions and the right hemisphere the seat of negative emotions. Consequently, positive emotional expressions should be more intensely expressed on the right side of the face and negative expressions should be more intense on the left side of the face.

Although Dimberg and Petterson (2000) compared left and right sided hemifacial EMG reactions, and supported the hypothesis that right brain hemisphere is predominantly involved in spontaneously evoked emotional responses, they did so using positive and negative facial expressions as a stimulus. Other research has suggested that different patterns of facial muscle activity have been shown to discriminate between subjective normal- and clinical-mood states produced by affective imagery (Schwartz, et al., 1976, 1978; Schwartz et al., 1980; Teasdale & Bancroft, 1977). This research has demonstrated increases in CS associated with negative affective imagery and increases in ZM associated with positive affective imagery. Further the ZM effects for positive emotions tend to be stronger on the right side of the face in right-handed subjects, which is consistent with the hypothesis that left hemisphere in right handed subjects, may play a special role in positive emotions (e.g. Ahern & Schwartz, 1979; Schwartz et al., 1979).

In relation to the present study, a firm conclusion cannot be made as to why the fluency effect is on the right side of the face. One possible explanation may be the difference in whether the stimuli are emotive or non-emotive. Another difference may be in the task (motor task vs. visual task), especially if performing a motor task is hand specific (i.e. must be right hand). That is, when emotion is evoked by a motor action, the emotion may be most strongly represented in the hemisphere that is controlling the action. Alternatively emotion associated with motor actions may be most strongly represented in the left hemisphere, regardless of the side of the body that is performing the action. This is another open question that warrants further investigation in the future.

The overall fluency effect for the imagery segment is lower than for the preview and postview segments. One reason for this may be that more dimensions are being appraised during the imagery segment, as discussed above. A related explanation involves kinaesthetic processes. The results of study 3 of this thesis indicate that for an affective response to be found in imaged motor fluency, then KIN needs to be a component of the image. However, the strength of the KIN cues may not be as strong during imagery as during the preview segment or the participants may not be attending to them as well in the imagery segment as they were in the preview segment. As noted above, when coding the programme for action participants may have concentrated on the specific part of the action that related most strongly to the change in fluency. This may have created a strong feeling for the difference in fluency conditions that the participants were able to attend to. When participants moved on to complete the imagery portion, the section of the task that was creating the strongest KIN sensations for fluency affect has now been incorporated back into the action as a whole. As it is now the entire action that is being imaged, the difference in KIN cues between fluent and non-fluent trials that were so dominant in the preview section may be drowned out with the introduction of other KIN cues to complete the task.

Within the literature, there is evidence to support the fact that visual and kinaesthetic imagery can be used concurrently (Callow & Hardy, 2004; Hardy & Callow, 1999). However, there is little research to establish the order in which these modalities are experienced. In relation to the present study, order effect of imagery may be important. Participants were instructed to use IVI and

KIN. However, they were not instructed as regards the order of usage (i.e. use IVI then KIN, use KIN then IVI, use both together). As a result the participants may have switched order. In the preview segment, participants were viewing the scene so may have attended to the KIN cues more as they may have felt that there was no need for IVI. When the trial moved into the imagery segment, participants may have switched to using IVI and not incorporated the KIN cues as they felt that they had already used the KIN in the preview segment and did not need to incorporate it into the imagery segment. Also, in the imagery segment the visual scene is no longer visible so they participants may have attended more to creating visual images. As is evident from Study 3, KIN is necessary for the fluency affect response, therefore if participants were switching the order that they were using imagery then the KIN element may not have been present in time window one of the imagery and this resulted in the affective response in time window 2 of imagery due to switching back to KIN. However, this is purely speculative in nature and more research may be needed on the order of imagery usage question.

Postview Segment

The results for the postview segment are similar to the results found in the imagery segment. That is, ZM was more active for fluent actions than for non-fluent actions, but there was no fluency effect for CS. The ZM fluency result was again only evident on the right side of the face. The fact that the fluency effect persists into the postview segment may be due to the participants reappraising the imaged actions. Alternatively, this may simply be a carryover from the end of the imagery period, but boosted by seeing the visual scene again. That is, when the scene is viewed, it is likely that there is an activation of the automatic simulation of the appropriate action.

Effort and Preference

When making decisions about an action, the rewards of that action must be weighed against the cost of the same action. Within the costs one must also consider the intrinsic costs, and in particular cost associated with effort. Previous research has indicated the role of effort in decision making. The law of least effort has stipulated that given two lines of action leading to equal rewards, the least effortful one will be typically chosen (Solomon, 1948). In relation to the present study, participants perform the same action with the same goal and only differ in the path they take. Nevertheless, the difference that this path change makes to the fluency condition is enough for participants to feel that there is more effort involved in the non-fluent condition and to have more of a preference for the fluent condition. Thus these simple actions seem to evoke emotions, supporting research showing that imaged action can influence emotion even when not attending to emotions.

Conclusions from Study 4

Previous work (Cannon et al., 2010) has shown that sensorimotor fluency evokes positive emotion that can be detected using direct physiological recording techniques that do not require conscious report. However, this is the first study to use imaged fluent and non-fluent motor actions to measure affective responses to non-emotive stimuli. It is very important to note that participants were not in any way aware that their emotional response was relevant to the study. The sole goal was to image moving the item from platform 1 to platform 2 as quickly and as accurately as possible, and there was no indication in the post-experiment questionnaires that participants suspected emotion was a component of the study. Therefore, it can be assumed that the emotional responses that are detected by the fEMG are spontaneous and not affected by task demands. This is important as it contests arguments that processing fluency does not affect emotional reactions directly. As reviewed by Winkielman and Cacioppo (2001), some models account for changes in explicit liking ratings due to perceptual fluency without any reference to the affect system. Rather, participants experience a change in processing fluency, and then attempt to explain this experience via the explicit task demands of evaluating the stimuli. In this account there is no direct emotional experience only a subsequent reinterpretation in terms of possible emotions. The present data cannot be explained in this way. The data therefore support the hedonic model, in which fluency produces a direct experience of affect (Reber et al., 1998; Winkielman & Cacioppo, 2001, Winkielman et al., 2003).

In conclusion, the current study supports the notion that emotional responses to imaged actions can be measured even when not attending to emotional states. It also supports previous studies that indicated that ease of motor fluency results in a direct experience of positive affect, but expands the findings to this previous research by demonstrating that imaged motor fluency increases positive affect and that, at least in this particular context, fluency related affect is stronger during the planning of the action than during the imaging of the action.

Chapter 5

General Discussion

Previous research has shown that self-produced non-emotive actions can result in an affective response (Hayes, et al., 2008). More specifically, it has been demonstrated that items that are the object of fluent interactions (where there is no obstacle or barrier in the movement path) are rated more positively than those that are the object of non-fluent interactions. The experimental chapters in this thesis aimed to extend the findings of Hayes, et al. (2008), and investigate whether motor fluency influences affect during a motor imagery task. Affective responses were measured both explicitly and implicitly. As previous research has shown (Decety, 1996), imaged actions and executed actions share common neural mechanisms, therefore it is logical to assume that imaged actions will result in the same affective response as executed actions. That is, in line with the findings of Hayes et al. (2008) that fluent actions result in more positive affective responses, it was hypothesised that imaged actions will produce similar affective responses. Additionally, the current thesis investigated the role of modality in affective responses.

Review of Experimental Chapters

Study 2.1 demonstrated that affective responses could be elicited for an imaged action. The study implemented a motor fluency methodology replicating the design of Hayes et al., (2008). In this task, participants were assigned to one of two imagery groups; the movement imagery group (MIG) that imaged performing fluent (no obstacle or barrier in the way) and non-fluent actions (had to avoid an obstacle or barrier) and the static imagery group (SIG) where participants were asked to image the scene as it appeared in front of them, but there was no movement in their image. After each image the participants rated on a likert scale the items that they imaged moving (MIG) or were part of the scene (SIG). Results indicated more positive affective responses following imagery of fluent actions, indicating that emotional responses may be elicited without the presence of actual overt movement. The effect was only observed when the movement was imaged (MIG) and not when the static scenes were imaged (SIG), thus indicating that the results cannot be accounted for by differences in the fluent vs. non-fluent visual scenes alone.

Another finding was related to imagery perspective used to complete the task. Participants were not assigned a specific imagery perspective (IVI or EVI) or modality (visual or KIN). However, participants spontaneously chose to complete the task using an IVI perspective, in keeping with the findings of White and Hardy (1995) where IVI was found to be more suited to tasks that rely more on perceptual information for performance. Although the participants had a preference in this case for IVI (as measured on the VMIQ-2), after the task when they rated their visual imagery perspective preference for completing the task, results indicated a greater preference for IVI compared to their VMIQ-2 score.

Study 2.2 investigated imagery ability correlates with evoked affect. Fluency dependent affect (the difference between affective ratings for fluent actions and the affective ratings for non-fluent actions) was correlated with imagery ability scores (EVI, IVI, Visual [EVI + IVI], KIN, total imagery ability -as measured by the VMIQ-2; Roberts, et al., 2008). The results indicated correlations between KIN ability and fluency dependent affect (overall fluency dependent affect, household items fluency dependent affect and abstract items fluency dependent affect), with better ability to image using KIN resulting in positive affective response to fluency. These results highlighted the potential relationship between KIN ability and fluency dependent affect. However, Study 2.2 was correlational in nature and therefore causality cannot be assumed. That is we do not know whether an individual's KIN ability results in greater fluency dependent affect or whether the relationship is as a result of a confounding variable. Given this, Study 3 was conducted to determined experimentally whether KIN processes drive affect more than visual processes, by controlling KIN and visual imagery usage.

Study 3 investigated whether the quality of an imaged motor interaction will influence an emotional response to the object and whether this is moderated by imagery modality. Participants completed the same task as MIG participants in Study 2.1, however this time they were given explicit instructions to adhere to a particular imagery modality when completing the task; internal visual imagery only (IVI- use 1st person perspective), kinaesthetic imagery only (KIN – image the feelings associated with the actions), or a combination of IVI and KIN. The results indicated that there was a fluency x group interaction; the effect of fluency on affect was only significant for the groups that utilised KIN. When the motor actions were only visually imaged there was no affective response to fluency   Chapter 2 and 3 provided evidence that imaged actions can evoke an affective response similar to that of actual movements. However, one of the draw backs of these two chapters was that there was an explicit response given for affective ratings. This meant that participants were actively attending to their affective responses and this in turn may have influenced their affective responses. A technique that avoids this difficulty is to measure affective responses by directly measuring facial expressions using electromyography (EMG). Previous work (Cannon et al., 2010) has shown that sensorimotor fluency evokes positive emotion that can be detected using direct physiological recording techniques that do not require conscious report. However, this is the first study to use imaged fluent and non-fluent motor actions to measure affective responses to non-emotive stimuli. In Study 4, the EMG technique was used replicating the task performed by the IVI/KIN group from Study 3 in an attempt to implicitly measure evoked affect. Replicating the behavioural results of the previous studies, there was a strong affective response for fluency of imaged actions. The EMG measure revealed that while imaging motor actions, the participants smiled more when imaging fluent actions than when imagining non-fluent actions. This effect was strongest during the planning of the imaged action. Although this replicated the findings of Cannon et al., (2010) that increased compatibility resulted in increased smiling, and Winkielman and Cacioppo (2001) who found that increased perceptual fluency resulted in increased smiling but not frowning, there is one difference. In the present study, during the imaging of the motor action, the fluency result was only observed on the right side of the face. Taking together the findings of all the experimental chapters, the theoretical implications will be discusses in the following section.

The Role of kinaesthetic imagery in fluency evoked affective response

Study 2.1 of this thesis demonstrated that motor fluency of imaged actions produces the same affective response as the motor fluency of physically performed actions. However, this was only evident when the action was imaged using KIN (Study 3). The results of Study 2.2 and Study 3 have highlighted the role of kinaesthetic imagery modality in relation to fluency evoked affect. So why is KIN more effective in evoking affective responses?

Physiological literature has proposed that kinaesthetic sensations concern movement, effort, heaviness, and position, and that it is these sensations that provide information that allows the system to determine limb location and the agent responsible for moving them (Enoka, 1994). Research suggests that imagery mirrors its genuine sensory or perceptual counterparts (Richardson, 1969). Furthermore, due to the fact that motor preparation/execution and kinaesthetic imagery involve the same motor representation system (functional equivalence and use of common neural pathways), then the experiences of an actual movement and the kinaesthetic image of that movement have the potential to be similar. Research using fMRI has supported this proposal. For example, Guillot et al. (2009) investigated the cerebral structures involved in internal visual imagery and kinaesthetic imagery in an explicitly known finger sequence. The results indicated that for the kinaesthetic imagery there was activation in several motor related regions, whereas VI shares common occipital substrates with visual perception. The authors suggested that the parallel characteristic between motor imagery and physical movements may be based on the incorporation of the motor programme and its corresponding sensory feedback, which is more directly available during kinaesthetic imagery (Koch, et al., 2004; Prinz, 1997; Wulf, & Prinz, 2001).

This link between kinaesthetic imagery and the motor system highlights the role of embodiment in emotional responses. Embodiment refers to the assumption that feelings, behaviours and thoughts are grounded in bodily interactions with the environment (Barsalou, 2008; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Spellman & Schnall, 2009). Thus given this contention that mental processes involve simulations of body-related perceptions and actions, then it may be reasonable to assume that affective responses found within this thesis are a result of more than just a cognitive, disembodied, understanding of the action. Indeed a limitation to the study of Hayes et al. (2008) was that although an embodiment explanation was consistent with their results, an alternative explanation could not be discounted. For example, their result may have stemmed purely from the cognitive understanding of the scene, with little or no influence of motor processes on the affective response. However, given that kinaesthetic imagery is required to elicit a significant emotional response, and kinaesthetic imagery activates the motor areas of the brain, then cognitive understanding of the action is not enough. Put another way, people understand that there is an obstacle in their movement path, and individuals understand the meaning of an obstacle. In Study 3, individuals in all groups had this understanding of the meaning of an obstacle, however this cognitive understanding was not enough to trigger the emotional response. It is highlighted here (through kinaesthetic imagery that the motor system needs to be activated in some way for motor fluency to evoke affect.

Another theoretical contribution of this thesis, highlighted in particular by Study 3, is that it provides support for the notion that IVI and KIN are two separable processes. If this was not the case it would not be possible for IVI and IVI/KIN groups in Study 3 to show different emotional responses to fluency.

In addition to these theoretical contributions regarding the role of KIN in fluency related affect, the findings here also highlight the potential applied implications for using kinaesthetic imagery in performance of motor actions, and these will be discussed in a later section.

Implicit affective findings

Study 4 highlights the fact that emotional responses can occur spontaneously, even when not attending to emotional states. This is important for generalising the results to everyday actions, as with non-emotional everyday actions individuals have tendency not to attend to emotional states elicited by actions. The use of facial EMG also allowed us to track the emotional response over the time period of the task, highlighting that the strongest emotional response, in this particular context at least, is at the planning stage of the action. There was also a positive emotional response while imagining the action but in a more limited way (right side of the face only and time window two only).

It is somewhat surprising that the strongest affective response to fluency occurs during the preview segment. It is interesting to consider what the source of this affect might be. Throughout the thesis, it has been highlighted that there is evidence to suggest that perceiving an object automatically induces a mental simulation of how one might act on that object even if there is no explicit intention to act (e.g. Tucker & Elllis, 1998). This simulation may provide feedback as to how easy or difficult it is to interaction with an object. If individuals are more prone to complete easier actions, then it follows that preferences for one item over another may be driven by the motor system (Ping, et al., 2009). Given this, it could be contended that the results in the preview segment of Study 4 were not due to affective responses based on the KIN cues associated with planning the imaged movement but were in fact an automatic activation of the motor system due to the viewing of the stimulus. As Study 4 used a combination of IVI and KIN for the completion of the task, it is impossible to distinguish the influence of either independently on the affective response present.

One possible way to distinguish the visual and kinaesthetic imagery influences on the affect would be to repeat Study 4 using the IVI only and KIN only groups from Study 3. The results may clarify whether the results of Study 4 were due to planning of KIN components of the imagery or whether it is due to automatic activation of the motor system when viewing the scene. Given that in

Study 3 the IVI only group did not show an effect of fluency on explicit affective ratings, it might be expected that at the end of a trial there would be no evidence from fEMG of a fluency effect. However, it is possible that even in the IVI only group, fEMG might reveal a fluency effect at the preview stage of the trial, due to automatic activation of motor processes when viewing the scene. It is possible that such an effect might occur and then die away because the imagery task for the IVI only group does not engage kinaesthetic processes.

Motor fluency and effort

As noted in the general introduction, there is no definition for fluency. It was also noted that effort was one characteristic of motor actions that may differ in fluent and non-fluent situations. The data within the experimental chapters provides supper for the notion that effort is related to affect as demonstrated by correlational analysis. Effort is also considered to be a component of KIN processes (for a review see Fortier & Basset, 2012) as well as KIN imagery. For example, Callow and Waters (2005) put forward a possible definition of KIN imagery as “imagery involving the sensations of how it feels to perform an action, including the force and effort involved in movement and balance, and spatial location” (pp 444-445). Therefore, one future direction from this research is to investigate whether affective responses are as the result of perceived effort, or whether other KIN components are involved.

This may raise concern in relation to the present research that the results here do not represent affect, but instead simply represent effort. However, this is unlikely to be the case given the results of Study 4.

In Study 4, there is an affective response present, demonstrated by the zygomaticus major muscle activity. Previous research has shown that in a sustained information processing task there was higher muscle activity in the corrugator supercilii, orbicularis, and frontalis muscles, but there were no effects observed in the zygomaticus major muscle (Waterink & van Boxtel, 1994). If the effects in the Study 4 were due to effort then the corrugator would show increased muscle activity for non-fluent task and the zygomaticus major would show no effects. As the zygomaticus major show an effect in both the pre-view and the imagery segment (time window two) then effort may be ruled out as a sole explanation.

Functions of Fluency Affect

Winkielman and Cacioppo (2001) discussed the affective consequences of perceptual fluency in terms of the hedonic fluency model. They suggested that the positive affect associated with processing ease may serve two functions. Firstly, it provides information about the state of internal processing and about the environment, which may be important with regard to approach or avoid decisions. For example, ease of perceptual fluency may indicate a familiarity of the stimulus and that it is safe to approach. Secondly, this positive affect associated with processing fluency may serve as a reward system that can facilitate continued processing.

The affect that motor fluency evokes may serve similar functions. The affective signal may direct attention towards items that are most suitable for efficient interactions. The motor related affect may also feed back into the reward system. That is people will feel more positive towards well executed actions and this may facilitate skill learning.

From an applied perspective, the potential of promoting the use of KIN cues in rehearsing fluent and non-fluent actions are also highlighted. Within the sports science literature, theoretical reasoning (e.g. Fitz & Posner, 1967) and results presented in Hardy and Callow (1999) suggest that for form based task KIN can produce additional performance benefits. However as previously mentioned, research indicates that for form based tasks then the use of external visual imagery is more effective than internal visual imagery (White & Hardy, 1995), and this thesis utilised internal visual imagery. Research has yet to examine whether tasks that require perceptual information would benefit from the incorporation of KIN. However, it makes instinctive sense that for a perceptual information task KIN would provide useful additional information that would in turn enhance performance and given this Callow and Hardy (2005) tentatively recommend the use of KIN imagery.

The research in this thesis has demonstrated that incorporating a KIN component results in affective responses to motor fluency. This affective signal may be a mechanism by which KIN improves motor performance. When imagining actions fluently imaged actions result in more positive affective responses, which may serve as a reward mechanism that facilitates skill acquisition. This possibility is at this point speculative, but it does strengthen the case for including KIN when using imagery to improve motor learning.

Context of emotional responses to motor fluency

Within this thesis, the results have shown that fluent imaged actions evoke a more positive affect. However, in some cases individuals prefer to perform an action that is more difficult than an easier one, even at the expense of a fluent performance. This may occur in situations where the overall affective response may be dominated by other sources of affect. This is in keeping with the appraisal theory of emotions (see Ellsworth & Scherer, 2003 for review). Once the stimulus is appraised at the basic level the stimulus may be assessed on a number of additional dimensions which may include the individuals' needs and goals. Satisfaction of a goal will evoke positive affect, but also the rate of progress towards a goal is thought to be an important source of affect (Carver & Scheier, 1990). These goal-related evaluations are likely to be highly relevant for motor events. For example, instead of simply dropping a crumpled piece of paper into the bin, a person might try throwing it around his back.

It should be noted, therefore, that the effect of fluency on affect may be influenced by the context in which the fluency occurs. An example of this may be where during the skill the fluency occurs. Many actions require sequential execution of multiple movements to complete the action.

For example in this thesis, the movement was to reach out, grasp and pick up an item, move (either fluently or non-fluently) to a target, place the item down and return hand to where it started. The fluency component of the action was in the middle movement (moving from resting place to the target). However, if the task was to change and the fluent/non-fluent component was to occur at either the beginning of the action or at the end, might this effect affective response. This is an open question that warrants further investigation.

Future Directions

This thesis investigates whether affective responses can be evoked through imaged motor fluency. The studies detailed above confirm that this is the case. However, there are still some questions about the exact nature of imaged motor fluency. This next section will discuss these potential research questions.

Generalisation of implicit affective responses to performed actions:

This thesis lends support to the notion that non-emotive fluent and non-fluent imaged actions can result in spontaneous affective responses and that this may be driven by the motor system. It has not yet been tested whether emotion is evoked implicitly when the equivalent actions are performed. Although there is research supporting the notion of functional equivalence, exploring effects with performed actions compared to imaged actions may be warranted.

A possible method of doing this would be to repeat the study of Hayes et al. (2008), but using facial EMG as a measure of affective responses. In this way it would be possible to examine whether emotional reactions to fluent and non-fluent actions will occur spontaneously. Given the results of Cannon et al., (2010) and the studies in this thesis, it could be assumed that physically performed actions will result in a spontaneous affective response. The use of facial EMG in this way would also allow the tracking of the time course of the task and to establish where the affective response occurs.

The role of imagery ability in fluency effect evoked by performed actions: Research has shown that imagery can benefit performance. The better ones ability to image the greater the influence that imagery will have on actions. Study 2.2 of this thesis indicated that there was a correlational relationship between kinaesthetic imagery ability and fluency dependent affect (affective ratings for fluent actions minus affective ratings for non-fluent actions). If you have greater KIN ability, this may be associated with greater KIN cue utilisation in actual performance. If this was the case, then it stands that higher kinaesthetic imagery ability may influence the affective responses in performed actions as well as imaged actions. This is a question that also warrants further investigation and is in progress of being investigated.

The role of external visual imagery in affective response:

This thesis has focused on the internal visual imagery perspective. This was due to previous research showing that internal visual imagery is more effective in tasks that require perceptual information (White & Hardy, 1995), as was the case with the task that the participants performed in this thesis. However, would the same emotional response be obtained if the task was performed from an external visual imagery perspective? Research indicates that the nature of some images make them more emotional than others. Research in emotional disorders indicated that the perspective adapted in mental imagery can have emotional consequences, with first person perspective having a greater emotional effect (Libby, Shaeffer, Eibach, & Slemmer, 2007). However, within the thesis it has emerged that kinaesthetic imagery may be the driving force behind the affective response as it is the motor system activation that results in an affective response. Therefore, if this task was imaged from an external visual perspective would an affective response still be evoked? Or is the visual perspective used more related to task traits (i.e. internal for perceptual based tasks and external for form based tasks) and it is the utilisation of the KIN cues that result in an affective response in non-emotional tasks. A possible way to investigate this would be to repeat Studies 3 and 4 using an external perspective rather than an internal visual perspective. Similarly, instead of using a perceptual based task in the study, a form based fluency task could be employed to investigate using both visual perspectives and combining them with kinaesthetic imagery.

Conclusion

Based on the findings of this thesis, we now know that fluent imaged actions evoke affective responses and that the motor system (as triggered by KIN imagery) plays an important role in eliciting affective responses to fluent and non-fluent actions. Emotional responses to imaged motor fluency can occur whether attending to or not attending to affective responses, which suggests that affective responses to imaged action fluency occurs spontaneously and may therefore be a common everyday experience. The thesis opens up a number of future research directions for investigating how everyday action evokes emotion.

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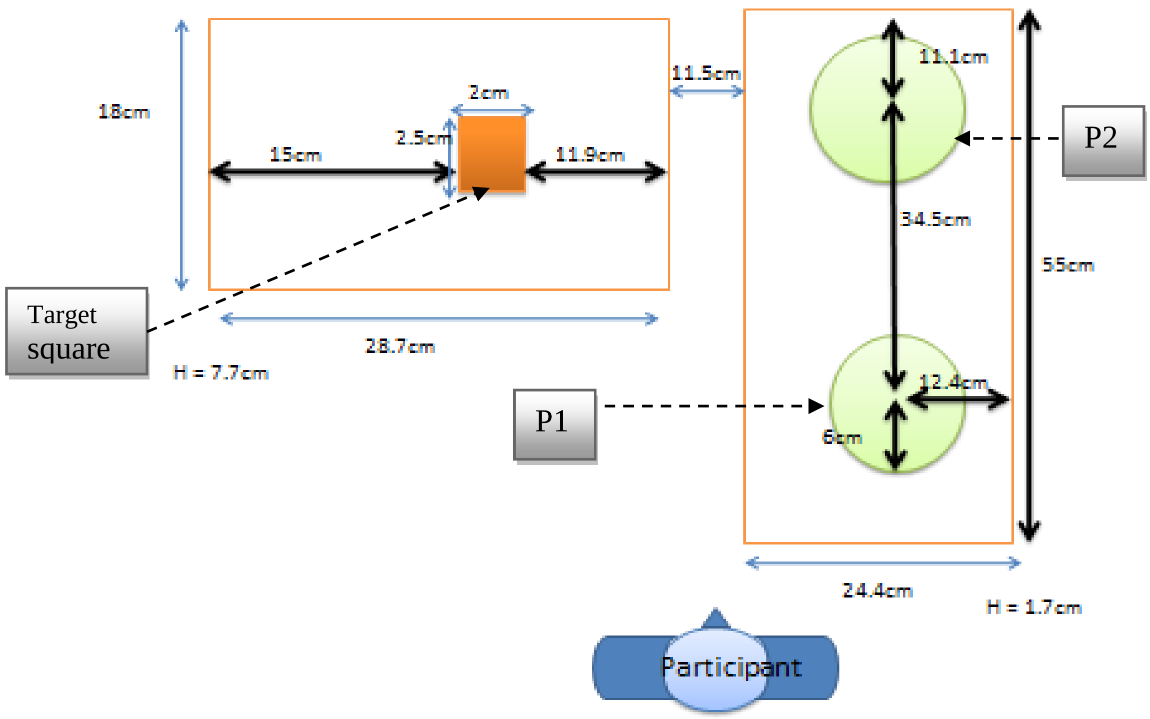
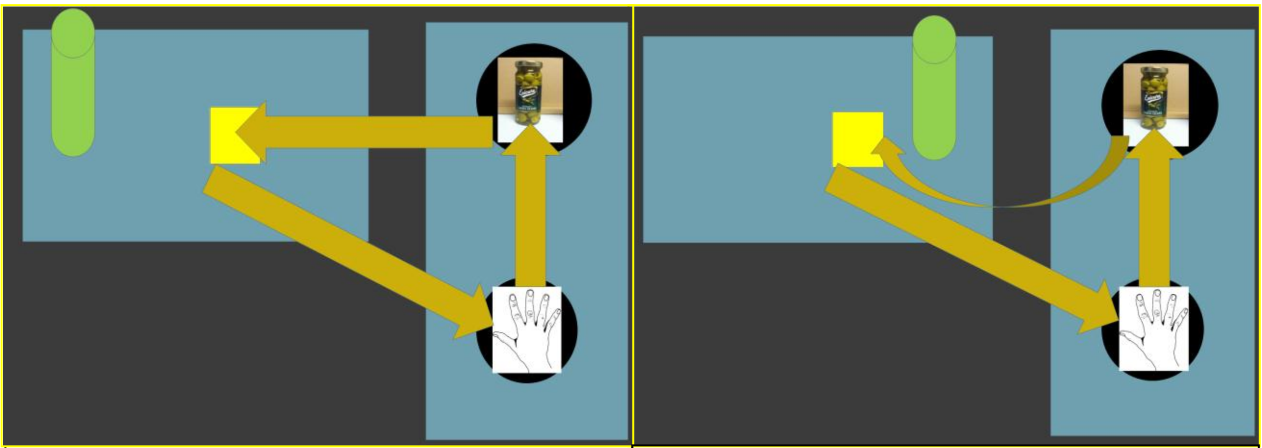
Appendices

Appendix 1

Schematic of Apparatus





Fluent condition: Image moving the hand forward, picking up item, moving item to target (orange square), placing item down and returning hand to where started.	**Non-fluent condition:** Image moving hand forward, picking item up, moving item around the obstacle to the target (orange square), placing item down and returning hand to where it started.

Appendix 2

VMIQ-2

Vividness of Movement Imagery Questionnaire-2

Name: **Age:**

Gender: **Sport:**

Level at which sport is played at (e.g., Recreational, Club, University, National, International, Professional)

Years spent participating in this sport competitively:

Movement imagery refers to the ability to imagine a movement. The aim of this questionnaire is to determine the vividness of your movement imagery. The items of the questionnaire are designed to bring certain images to your mind. You are asked to rate the vividness of each item by reference to the 5-point scale. After each item, circle the appropriate number in the boxes provided. The first column is for an image obtained watching yourself from an external point of view (External Visual Imagery), and the second column is for an image obtained from an internal point of view, as if you were looking through your own eyes (Internal Visual Imagery). The third column is for an image obtained by feeling yourself do the movement (Kinaesthetic imagery). Try to do each item separately, independently of how you may have done other items. Complete all items from an external visual perspective and then return to the beginning of the questionnaire and complete all of the items from an internal visual perspective, and finally return to the beginning of the questionnaire and complete the items while feeling the movement. The three ratings for a given item may not in all cases be the same. For all items please have your eyes CLOSED.

Think of each of the following acts that appear on the next page, and classify the images according to the degree of clearness and vividness as shown on the RATING SCALE.

RATING SCALE. The image aroused by each item might be:

Perfectly clear and as vivid (as normal vision or feel of movement)	……………	RATING 1
Clear and reasonably vivid	……………	RATING 2
Moderately clear and vivid	……………	RATING 3
Vague and dim	……………	RATING 4
No image at all, you only “know” that you are thinking of the skill	……………	RATING 5

Item	Watching yourself do it (External Visual Imagery)					Looking through your own eyes (Internal Visual Imagery)					Feeling yourself do it (Kinaesthetic Imagery)				
	Perfectly clear and vivid as normal vision	Clear and reasonably vivid	Moderately clear and vivid	Vague and dim	No image at all, you only know that you are thinking of the skill	Perfectly clear and vivid as normal vision	Clear and reasonably vivid	Moderately clear and vivid	Vague and dim	No image at all, you only know that you are thinking of the skill	Perfectly clear and vivid as normal feel of movement	Clear and reasonably vivid	Moderately clear and vivid	Vague and dim	No image at all, you only know that you are thinking of the skill
1.Walking	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2.Running	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3.Kicking a stone	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
4.Bending to pick up a coin	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
5.Running up stairs	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
6.Jumping sideways	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
7.Throwing a stone into water	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
8.Kicking a ball in the air	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
9.Running downhill	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
10.Riding a bike	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
11.Swinging on a rope	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
12.Jumping off a high wall	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

1. Please indicate if you have a preference for using a particular visual imagery perspective on this scale (if you have no preference then circle 5):

0	1	2	3	4	5	6	7	8	9	10
Strong preference internal			Moderate preference internal		No preference		Moderate preference external			Strong preference external

2. Please indicate on the following questions the extent to which you “switched” between imagery perspectives, when completing the two visual columns of the adapted VMIQ:

a) When completing the *watching yourself do it* (External Visual Imagery) column, what perspective did you use?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		minimal switching to an external perspective			switched regularly			minimal switching to an internal perspective		completely external perspective

b) When completing the *looking through your own eyes* (Internal Visual Imagery) column, what perspective did you use?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		minimal switching to an external perspective			switched regularly			minimal switching to an internal perspective		completely external perspective

3. When completing the two visual imagery columns please specify if you used kinaesthetic imagery at the same time as the designated visual imagery perspective:

EVI

0	1	2	3	4	5	6	7	8	9	10
No kinaesthetic imagery use										high kinaesthetic imagery use

IVI

0	1	2	3	4	5	6	7	8	9	10
No kinaesthetic imagery use										high kinaesthetic imagery use

4. If you used kinaesthetic imagery at the same time as the designated visual perspective please denote (Using the numbers 3 = most often, 1 = least often) the order in which visual and kinaesthetic imagery were used

EVI	IVI
Visual and Kinaesthetic imagery at the same time _______ Visual then kinaesthetic imagery _______ Kinaesthetic then visual imagery _______	Visual and Kinaesthetic imagery at the same time _______ Visual then kinaesthetic imagery _______ Kinaesthetic then visual imagery _______

5. On <u>one</u> of the diagrams below, please draw an arrow and provide a short explanation to illustrate where you imaged from most of the time, when completing the external visual imagery column.

Appendix 3

Imagery Scripts Movement Imagery Group and Static Imagery Group (Study 2.1 & 2.2)

Imagery Script – Movement Imagery Group

Start when you are ready. You are going to go through an imagery script. Read through the imagery script. Once you have read it, try to see and feel what is described to you.

Image the scene as it appears in front of you ……….image the platform to your left……..the vase that is there... …..its position………Image the platform to your right…… the item …..… image your hand resting comfortably on the platform ……..……….. image yourself moving your hand and reaching out to grasp the item on the platform……..your hand closes around the item, gripping it securely and lifting it from its resting place…..image the movement of your hand as it brings the item towards the target……..your arm reaches the destination platform on your left and you are setting the item down on the target…………image your hand as you release the item and your hand returns to the starting plate………Try to image this as vividly as you can…………

Imagery Script- Static Imagery Group

Start when you are ready. You are going to go through an imagery script. Read through the imagery script. Once you have read it, try to see and feel what is described to you.

Image the scene that appears in front of you….......... there are two platforms in the scene……..there is a platform to your left…. Image this platform……. There is vase on this platform………….. image this vase………………… image the position of the vase…………… There is a platform to your right……… image this platform…….. there are two discs on this platform.....…….image these two discs……. There is an item resting on the disc at the top of the platform……….. image this item………. Use imagery to create a picture of the entire scene that has been described to you………. Image all elements that appear in the scene…….... hold this image in your mind…............. try to create as clear an image of this as you can…………

Appendix 4

Post Experimental Questionnaires for studies 2.1 & 2.2 for both Movement Imagery Group & Static Imagery Group.

Post Experimental Questionnaire – ADMINISTERED AFTER IMAGERY TASK

Rating Task Questions

1. What did you base your liking ratings on?

2. During the rating task did you image other imaginable types of the item?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

3. If you formed a visual image of other imaginable types of item, then please rate the overall vividness of the images by reference to the scale below:

Perfectly clear and vivid as normal vision	Clear and reasonably vivid	Moderately clear and vivid	Vague and dim	No image at all, you only know that you are thinking of the object
1	2	3	4	5

4. Were you aware of the different positions of the vase while doing the rating task?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

5. Did you feel that the positions of the vase contributed to your reported liking rating?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

6. Was there an adequate amount of time given for viewing the item during the rating task?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

Imagery Task Questions

7. To what degree did you feel you used visual imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No visual imagery use										High visual imagery use

8. Please indicate the form of visual imagery used when performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		Minimal switching to an external perspective			Switched regularly			Minimal switching to an internal perspective		Completely external perspective

8a.If you used external visual imagery, please indicate by way of an arrow and short explanation where you externally imaged from.

9. To what degree did you feel you used kinaesthetic imagery while imaging:

0	1	2	3	4	5	6	7	8	9	10
No kinaesthetic imagery use										High kinaesthetic imagery use

9a. If you used kinaesthetic imagery with visual imagery please denote (Using the numbers 3 = most often, 1 = least often) the order in which visual and kinaesthetic imagery were used

Visual and kinaesthetic imagery at the same time ______
Visual then kinaesthetic imagery ______
Kinaesthetic then visual imagery ______

9b. If you used kinaesthetic imagery, describe what you imaged using kinaesthetic imagery

With reference to the scales below, please rate how well you were able to image what is described. First complete the Visual Imagery column and then complete the Kinaesthetic Imagery column.

	Visualising yourself do it (Visual Imagery)					Feeling yourself do it (Kinaesthetic Imagery)				
	Perfectly clear and vivid as normal vision	Clear and reasonably vivid	Moderately clear and vivid	Vague and dim	No image at all, you only know that you are thinking of the movement	Perfectly clear and vivid as normal feel of movement	Clear and reasonably vivid	Moderately clear and vivid	Vague and dim	No image at all, you only know that you are thinking of the movement
1. Platform on the left	1	2	3	4	5					
2. Appearance of the vase	1	2	3	4	5					
3. Position of the vase	1	2	3	4	5					
4. Platform on the right	1	2	3	4	5					
5. Appearance and position of the item	1	2	3	4	5					
6. Hand resting on the platform	1	2	3	4	5	1	2	3	4	5
7. Moving hand to reach and grasp item	1	2	3	4	5	1	2	3	4	5
8. Gripping the item and lifting it	1	2	3	4	5	1	2	3	4	5
9. Moving towards the target	1	2	3	4	5	1	2	3	4	5
10. Setting item down.	1	2	3	4	5	1	2	3	4	5
11. Releasing the item and returning hand to starting plate	1	2	3	4	5	1	2	3	4	5

With reference to the scales below, please rate how well you were able to image what is described.

	Visualising yourself do it (Visual Imagery)				
	Perfectly clear and vivid as normal vision	Clear and reasonably vivid	Moderately clear and vivid	Vague and dim	No image at all, you only know that you are thinking of the skill
1. Platform on the left	1	2	3	4	5
2. Appearance of the vase	1	2	3	4	5
3. Position of the vase	1	2	3	4	5
4. Platform on the right	1	2	3	4	5
5. Appearance and position of the item	1	2	3	4	5

10. **How well do you think you were able to remember and include all components of the imagery script during the imagery task?**

0 1 2 3 4 5 6 7 8 9 10
Not at all **Greatly**

11. **When forming your images, did you take into account that the vase position was changing?**

0 1 2 3 4 5 6 7 8 9 10
Never **Sometimes** **Always**

12. **When forming your images, did you take into account that the item was changing?**

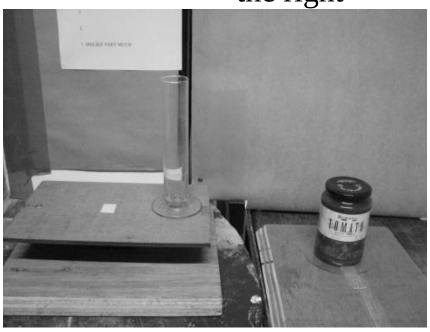
0 1 2 3 4 5 6 7 8 9 10
Never **Sometimes** **Always**

13. **Was there an adequate amount of time given for viewing the vase and the item before you had to begin imaging?**

0 1 2 3 4 5 6 7 8 9 10
Never **Sometimes** **Always**

14. **When completing the imagery task did you have a preference imaging when the vase was to the left side of the platform or when the vase was to the right side of the platform?**

0 1 2 3 4 5 6 7 8 9 10
Vase on the left No preference Vase on the right



15. When completing the imagery task, did you feel more effort was required when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					Equal effort					Vase on the right

<u>Post Experimental Questionnaire– ADMINISTERED AFTER ACTION TASK</u>

1. **In between each action, did you use imagery to enhance your performance?**

0	1	2	3	4	5	6	7	8	9	10
Never					Sometimes					Always

1a. Please elaborate on what your image contained?

2. **When completing the action task did you have a preference performing the action when the vase was to the left side of the platform or when the vase was to the right side of the platform?**

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					No preference					Vase on the right

3. **When completing the action task, did you feel more effort was required when the vase was to the left side of the platform or when the vase was to the right side of the platform?**

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					Equally effortful					Vase on the right

4. **To what extent do you feel you were prepared for this task as a result of the imagery task that you performed?**

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

5. **What research questions do you think this study is addressing?**

Appendix 5

Imagery scripts for Study 3 – IVI only group, KIN only group, IVI/KIN combination group

Scripts used for IVI/KIN combined group were also used for Study 4

Imagery Script (*Internal Visual Imagery Only)*

Start when you are ready. You are going to go through an imagery script. Read through the imagery script. Once you have read it, try to see what is described to you.

There are two platforms in front of you……. There is a platform on your left……… There is a vase on the platform…….. Notice this vase and its position……. There is a platform on your right…….. There is an item on this platform……. Your hand is also on the platform…… You are going to image seeing from a 1st person perspective picking up and moving this item as if you are actually performing the action……. See your hand reaching out to grasp the item on the platform…….. See your hand as it closes around the object……… See your hand gripping the item and lifting it from its resting place………. See your arm moving as you bring the item towards the target……….. Your hand reaches the destination platform on your left…….. See your hand setting the item down on the target and see yourself releasing your grip……….. See your arm moving back to where it started as you return your hand to the starting plate.

Imagery Script (*KIN Imagery Only)*

Start when you are ready. You are going to go through an imagery script. Read through the imagery script. Once you have read it, try to feel what is described to you.

There are two platforms in front of you……. There is a platform on your left……… There is a vase on the platform…….. Notice this vase and its position……. There is a platform on your right…….. There is an item on this platform……. Your hand is also on the platform…… You are going to image the feelings associate with picking up and moving this item as if you are actually performing the action ……. Feel your hand reaching out to grasp the item on the platform…….. Feel your hand as it closes around the object……… Feel your hand gripping the item and lifting it from its resting place………. Feel your arm moving as you bring the item towards the target……….. Your hand reaches the destination platform on your left…….. Feel your hand setting the item down on the target and Feel yourself releasing your grip……….. Feel your arm moving back to where it started as you return your hand to the starting plate.

<u>Imagery Script (</u>*IVI / KIN combined group)*

Start when you are ready. You are going to go through an imagery script. Read through the imagery script. Once you have read it, try to see and feel what is described to you.

There are two platforms in front of you……. There is a platform on your left……… There is a vase on the platform…….. Notice this vase and its position……. There is a platform on your right…….. There is an item on this platform……. Your hand is also on the platform…… You are going to image seeing from a 1st person perspective picking up and moving this item as well as the feelings associated with the action as if you were actually performing the action ……. See and feel your hand reaching out to grasp the item on the platform…….. See and feel your hand as it closes around the object……… See and feel your hand gripping the item and lifting it from its resting place………. See and feel your arm moving as you bring the item towards the target……….. Your hand reaches the destination platform on your left…….. See and feel your hand setting the item down on the target and See and feel yourself releasing your grip……….. See and feel your arm moving back to where it started as you return your hand to the starting plate.

Imagery Script (*KIN/IVI Combined group)*

Start when you are ready. You are going to go through an imagery script. Read through the imagery script. Once you have read it, try to feel and see what is described to you.

There are two platforms in front of you……. There is a platform on your left……… There is a vase on the platform…….. Notice this vase and its position……. There is a platform on your right…….. There is an item on this platform……. Your hand is also on the platform…… You are going to image the feelings associated with moving this item as well as seeing from a 1st person perspective the action as if you were actually performing action ……. feel and see your hand reaching out to grasp the item on the platform…….. feel and see your hand as it closes around the object……… feel and see your hand gripping the item and lifting it from its resting place………. feel and see your arm moving as you bring the item towards the target……….. Your hand reaches the destination platform on your left…….. feel and see your hand setting the item down on the target and feel and see yourself releasing your grip……….. feel and see your arm moving back to where it started as you return your hand to the starting plate.

Appendix 6

Study 3 – post experiment questionnaire IVI only group

<u>Post Experimental Questionnaire</u>

1. What did you base your liking ratings on?

2. During the rating task did you image other imaginable types of the item?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

3. Were you aware of the different positions of the vase while doing the rating task?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

4. Did you feel that the positions of the vase contributed to your reported liking rating?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

5. To what degree did you feel you used visual imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No visual imagery use										High visual imagery use

6. Please indicate the form of visual imagery used when performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		Minimal switching to an external perspective			Switched regularly			Minimal switching to an internal perspective		Completely external perspective

7. When completing the visual imagery, please specify if you used kinaesthetic imagery at the same time as the designated visual imagery perspective

0	1	2	3	4	5	6	7	8	9	10
No kinaesthetic imagery use										High kinaesthetic imagery use

NOTE: THE NEXT QUESTION IS ABOUT ***SWITCHING BETWEEN VISUAL IMAGERY MODALITIES***. SWITCHING REFERS TO MOVING BACK & FORTH BETWEEN VISUAL IMAGERY & KINAESTHETIC IMAGERY OVER THE DURATION OF COMPLETING THE IMAGE OF THE MOVEMENT (E.G. USING INTERNAL VISUAL IMAGERY **FOR A SECTION** OF THE MOVEMENT & KINAESTHETIC IMAGERY FOR ANOTHER SECTION)

8. During the task please indicate (if any at all) the degree of switching between perspectives when completing the image.

0	1	2	3	4	5	6	7	8	9	10
No switching between perspectives										High switching between perspectives

NOTE: THE NEXT QUESITON IS ABOUT ***ORDER OF MODALITIES USED.*** ORDER IS THE ARRANGEMENT OR SEQUENCE OF IMAGERY MODALITIES USED WITHIN THE IMAGE OF A MOVEMENT (E.G. USING VISUAL THEN KINAESTHETIC **WITHIN A SECTION** OF A MOVEMENT)

9. If you used kinaesthetic imagery with visual imagery please denote (using the numbers 3=most often, 2=often and 1=least often) the order in which visual and kinaesthetic imagery were used

Visual and kinaesthetic imagery at the same time ______
Visual then kinaesthetic imagery ______
Kinaesthetic then visual imagery ______

10. When forming your images, did you take into account that the vase position was changing?

0	1	2	3	4	5	6	7	8	9	10
Never					Sometimes					Always

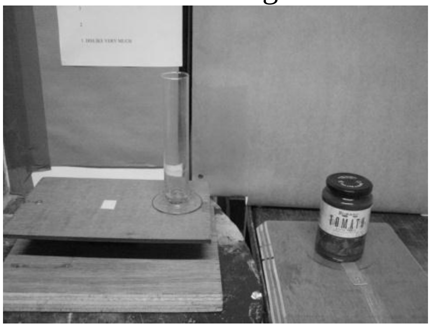
11. When forming your images, did you take into account that the item was changing?

0	1	2	3	4	5	6	7	8	9	10
Never					Sometimes					Always

12. When completing the imagery task did you have a preference imaging when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0 1 2 3 4 5 6 7 8 9 10

Vase on the left — No preference — Vase on the right



13.When completing the imagery task, did you feel more effort was required when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0 1 2 3 4 5 6 7 8 9 10

Vase on the left — Equal effort — Vase on the right

Appendix 7

Study 3 – post experiment questionnaire KIN only group

Post Experimental Questionnaire

1. What did you base your liking ratings on?

2. During the rating task did you image other imaginable types of the item?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

3. Were you aware of the different positions of the vase while doing the rating task?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

4. Did you feel that the positions of the vase contributed to your reported liking rating?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

5. To what degree did you feel you used kinaesthetic imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No KIN imagery use										High KIN imagery use

6. When completing the kinaesthetic imagery, please specify if you used visual imagery at the same time as the designated kinaesthetic imagery perspective

0	1	2	3	4	5	6	7	8	9	10
No visual imagery use										High visual imagery use

7. Please indicate the form of visual imagery used when performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		Minimal switching to an external perspective			Switched regularly			Minimal switching to an internal perspective		Completely external perspective

NOTE: THE NEXT QUESTION IS ABOUT ***SWITCHING BETWEEN VISUAL IMAGERY MODALITIES***. SWITCHING REFERS TO MOVING BACK & FORTH BETWEEN VISUAL IMAGERY & KINAESTHETIC IMAGERY OVER THE DURATION OF COMPLETING THE IMAGE OF THE MOVEMENT (E.G. USING INTERNAL VISUAL IMAGERY **FOR A SECTION** OF THE MOVEMENT & KINAESTHETIC IMAGERY FOR ANOTHER SECTION)

8. During the task please indicate (if any at all) the degree of switching between perspectives when completing the image.

0 1 2 3 4 5 6 7 8 9 10

No switching between perspectives — High switching between perspectives

NOTE: THE NEXT QUESITON IS ABOUT ***ORDER OF PERSPECTIVES USED.*** ORDER IS THE ARRANGEMENT OR SEQUENCE OF IMAGERY PERSPECTIVES USED TO COMPLETE AN IMAGE.

9. If you used kinaesthetic imagery with visual imagery please denote (using the numbers 3=most often, 2=often and 1=least often) the order in which visual and kinaesthetic imagery were used

Visual and kinaesthetic imagery at the same time ______
Visual then kinaesthetic imagery ______
Kinaesthetic then visual imagery ______

10. When forming your images, did you take into account that the vase position was changing?

0 1 2 3 4 5 6 7 8 9 10

Never **Sometimes** **Always**

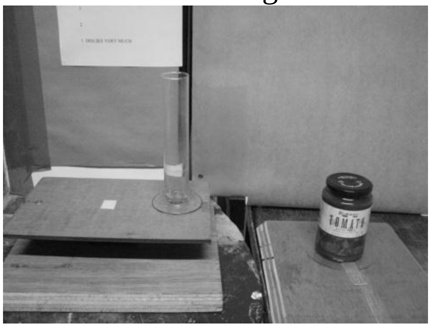
11. When forming your images, did you take into account that the item was changing?

0 1 2 3 4 5 6 7 8 9 10

Never **Sometimes** **Always**

12. When completing the imagery task did you have a preference imaging when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					No preference					Vase on the right



13. When completing the imagery task, did you feel more effort was required when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					Equal effort					Vase on the right

Appendix 8

Study 3 – post experiment questionnaires IVI/KIN combined group.

(Questionnaires with IVI questions 1st presented 1st, folled by questionnaires with KIN questions 1st presented 2nd).

Post Experimental Questionnaire (Visual imagery questions 1st)

1. What did you base your liking ratings on?

2. During the rating task did you image other imaginable types of the item?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

3. Were you aware of the different positions of the vase while doing the rating task?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

4. Did you feel that the positions of the vase contributed to your reported liking rating?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

5. To what degree did you feel you used visual imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No visual imagery use										High visual imagery use

6. Please indicate the form of visual imagery used when performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		Minimal switching to an external perspective			Switched regularly			Minimal switching to an internal perspective		Completely external perspective

7. To what degree did you feel you used kinaesthetic imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No KIN imagery use									High KIN	imagery use

NOTE: THE NEXT QUESTION IS ABOUT ***<u>SWITCHING BETWEEN VISUAL IMAGERY MODALITIES</u>***. SWITCHING REFERS TO MOVING BACK & FORTH BETWEEN VISUAL IMAGERY & KINAESTHETIC IMAGERY OVER THE DURATION OF COMPLETING THE IMAGE OF THE MOVEMENT (E.G. USING INTERNAL VISUAL IMAGERY **FOR A SECTION** OF THE MOVEMENT & KINAESTHETIC IMAGERY FOR ANOTHER SECTION)

8. During the task please indicate (if any at all) the degree of switching between perspectives when completing the image.

0	1	2	3	4	5	6	7	8	9	10
No switching between perspectives										High switching between perspectives

NOTE: THE NEXT QUESITON IS ABOUT ***<u>ORDER OF PERSPECTIVES USED.</u>*** ORDER IS THE ARRANGEMENT OR SEQUENCE OF IMAGERY PERSPECTIVES USED TO COMPLETE AN IMAGE.

9. If you used kinaesthetic imagery with visual imagery please denote (using the numbers 3=most often, 2=often and 1=least often) the order in which visual and kinaesthetic imagery were used

Visual and kinaesthetic imagery at the same time ______
Visual then kinaesthetic imagery ______
Kinaesthetic then visual imagery ______

10. When forming your images, did you take into account that the vase position was changing?

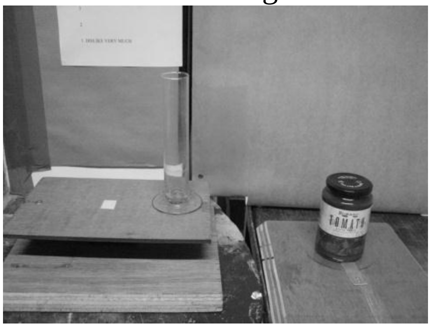
0	1	2	3	4	5	6	7	8	9	10
Never				**Sometimes**						**Always**

11. When forming your images, did you take into account that the item was changing?

0	1	2	3	4	5	6	7	8	9	10
Never				**Sometimes**						**Always**

12. When completing the imagery task did you have a preference imaging when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					No preference					Vase on the right



13. When completing the imagery task, did you feel more effort was required when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					Equal effort					Vase on the right

Post Experimental Questionnaire (KIN questions 1st)

1. What did you base your liking ratings on?

2. During the rating task did you image other imaginable types of the item?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

3. Were you aware of the different positions of the vase while doing the rating task?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

4. Did you feel that the positions of the vase contributed to your reported liking rating?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Greatly

5. To what degree did you feel you used kinaesthetic imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No KIN imagery use										High KIN imagery use

6. To what degree did you feel you used visual imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No visual imagery use										High visual imagery use

7. Please indicate the form of visual imagery used when performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		Minimal switching to an external perspective			Switched regularly			Minimal switching to an internal perspective		Completely external perspective

NOTE: THE NEXT QUESTION IS ABOUT ***SWITCHING BETWEEN VISUAL IMAGERY MODALITIES***. SWITCHING REFERS TO MOVING BACK & FORTH BETWEEN VISUAL IMAGERY & KINAESTHETIC IMAGERY OVER THE DURATION OF COMPLETING THE IMAGE OF THE MOVEMENT (E.G. USING INTERNAL VISUAL IMAGERY **FOR A SECTION** OF THE MOVEMENT & KINAESTHETIC IMAGERY FOR ANOTHER SECTION)

8. During the task please indicate (if any at all) the degree of switching between perspectives when completing the image.

0	1	2	3	4	5	6	7	8	9	10
No switching between perspectives										High switching between perspectives

NOTE: THE NEXT QUESITON IS ABOUT ***ORDER OF PERSPECTIVES USED.*** ORDER IS THE ARRANGEMENT OR SEQUENCE OF IMAGERY PERSPECTIVES USED TO COMPLETE AN IMAGE.

9. If you used kinaesthetic imagery with visual imagery please denote (using the numbers 3=most often, 2=often and 1=least often) the order in which visual and kinaesthetic imagery were used

Visual and kinaesthetic imagery at the same time ______
Visual then kinaesthetic imagery ______
Kinaesthetic then visual imagery ______

10. When forming your images, did you take into account that the vase position was changing?

0	1	2	3	4	5	6	7	8	9	10
Never					Sometimes					Always

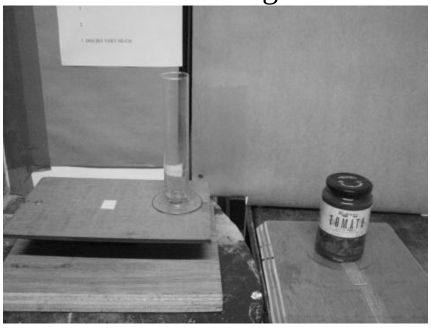
11. When forming your images, did you take into account that the item was changing?

0	1	2	3	4	5	6	7	8	9	10
Never					**Sometimes**					**Always**

12. When completing the imagery task did you have a preference imaging when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0 1 2 3 4 5 6 7 8 9 10

Vase on the left — No preference — Vase on the right



13. When completing the imagery task, did you feel more effort was required when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0 1 2 3 4 5 6 7 8 9 10

Vase on the left — Equal effort — Vase on the right

Appendix 9

Post experimental questionnaire Study 4

Participant______________

Post Experimental Questionnaire

1. What research question do you think this study is addressing?

2. To what degree did you feel you used visual imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No visual imagery use										High visual imagery use

3. Please indicate the form of visual imagery used when performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
Completely internal perspective		Minimal switching to an external perspective			Switched regularly			Minimal switching to an internal perspective		Completely external perspective

4. To what degree did you feel you used kinaesthetic imagery while performing the imagery task?

0	1	2	3	4	5	6	7	8	9	10
No KIN imagery use										High KIN imagery use

NOTE: THE NEXT QUESTION IS ABOUT ***SWITCHING BETWEEN VISUAL IMAGERY MODALITIES***. SWITCHING REFERS TO MOVING BACK & FORTH BETWEEN VISUAL IMAGERY & KINAESTHETIC IMAGERY OVER THE DURATION OF COMPLETING THE IMAGE OF THE MOVEMENT (E.G. USING INTERNAL VISUAL IMAGERY **FOR A SECTION** OF THE MOVEMENT & KINAESTHETIC IMAGERY FOR ANOTHER SECTION)

5. During the task please indicate (if any at all) the degree of switching between modalities when completing the image.

0	1	2	3	4	5	6	7	8	9	10
No switching between Modalities										High switching between Modalities

NOTE: THE NEXT QUESITON IS ABOUT ***ORDER OF PERSPECTIVES USED.*** ORDER IS THE ARRANGEMENT OR SEQUENCE OF IMAGERY PERSPECTIVES USED TO COMPLETE AN IMAGE.

6. If you used kinaesthetic imagery with visual imagery please denote (using the numbers 3=most often, 2=often and 1=least often) the order in which visual and kinaesthetic imagery were used

Visual and kinaesthetic imagery at the same time ______
Visual then kinaesthetic imagery ______
Kinaesthetic then visual imagery ______

7. When forming your images, did you take into account that the vase position was changing?

0	1	2	3	4	5	6	7	8	9	10
Never					**Sometimes**					**Always**

8. When forming your images, did you take into account that the item was changing?

0	1	2	3	4	5	6	7	8	9	10
Never					**Sometimes**					**Always**

9. When completing the imagery task did you have a preference imaging when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					No preference					Vase on the right

10. When completing the imagery task, did you feel more effort was required when the vase was to the left side of the platform or when the vase was to the right side of the platform?

0	1	2	3	4	5	6	7	8	9	10
Vase on the left					Equal effort					Vase on the right