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MOTIVATIONAL INTENSITY: DOES IT EXIST DISTINCT FROM VALENCE AND AROUSAL, AND DO ANY OF THEM AFFECT ATTENTIONAL BREADTH?

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Declaration

This thesis is submitted to the Australian National University as part of the requirements for the Doctor of Philosophy (Psychology). I was the first author for each of the published papers (Chapters 3 and 4), and my co-authors contribution is detailed at the start of each relevant empirical Chapter in the 'statements of contribution'. The co-authors of these Chapters (Dr. Amy Dawel, Associate Professor Mark Edwards, and Associate Professor Stephanie C. Goodhew) assisted with theoretical and conceptual development, experimental designs, data analyses, and the editing and writing of each of the published journal articles. I was the lead author for Chapters 1, 2, 5, and 7 and received support from my supervisors, Associate Professor Stephanie Goodhew, Associate Professor Mark Edwards, and Dr. Amy Dawel with initial structural and theoretical planning and editing.

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Abstract

Attentional breadth refers to the spatial extent of the attended region. Attentional breadth can be narrow, such as when reading the letters on this page, or it can be broad, such as taking in the layout of the room in front of you. It has been claimed that the valence (positive/negative) of one's emotional experience can change their breadth of attention, such that positive emotions broaden while negative emotions narrow attentional breadth. However, more recently it has been proposed that one's motivational intensity (i.e., strength of the urge to approach or avoid) is instead the true driver of attentional breadth. One of the aims of this thesis was to adjudicate between these competing theoretical models. However, before testing these theoretical models, it became apparent that the literature would benefit from a clearer understanding of how motivational intensity relates to the existing constructs of valence and arousal. Therefore, the first section of empirical work of this thesis (Chapters 3 and 4) examined the relationship between motivational intensity, valence, and arousal across a diverse set of affective stimuli and also via key specific categories of emotion which have been claimed to separate motivational intensity from valence (amusement, anger, awe, desire, and sadness). The collection of studies where a diverse range of affective stimuli were considered showed no consistent relationship between motivational intensity and arousal. However, there was an extremely high correlation between motivational intensity and valence. When the relationship between motivational intensity and valence was assessed across five key categories of emotion that had been suggested to differentiate them, a divergence emerged between motivational intensity and valence for sadness, anger, and amusement, confirming that motivational intensity and valence are separate constructs. Once these instances of divergence had been identified, it was possible to conduct the empirical work in Chapter 6 that examined the influence of motivational intensity versus valence on attentional breadth. The investigation was the first of its kind to simultaneously consider both of these factors, rather than attempting to

manipulate one of them without controlling for the other as previous research had typically done. Here, there was no observed effect of motivational intensity or valence on attentional breadth. Results conflict with previous theoretical models, but are consistent with a recent study's conclusion that emotion does not reliably impact attentional breadth. Future research could extend on the findings here to a greater range of conditions to determine if there is further support for the conclusion that emotion does not impact attentional breadth.

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"*There is nothing either good or bad, but thinking makes it so*"

William Shakespeare

Chapter 1: Emotion and Cognition

The emotions that we feel colour and flavour our everyday experiences. In fact, emotions play a large role in affecting our cognition, including influencing our memory, decision-making, problem-solving, risk-taking, and visual perception (Botdorf et al., 2017; George & Dane, 2016; Spering et al., 2005; Tyng et al., 2017; Xiao et al., 2021; Yang et al., 2017). Understanding the relationship between emotion and cognition is important because we use these different cognitive processes to manage inter-personal relationships, in the workplace, when taking care of our own mental well-being, and these processes also help us interact safely with our environment when doing important tasks such as driving (Cunningham & Regan, 2016; Feinberg et al., 2020; Lazarus, 2006; Yang et al., 2017).

One way of understanding the fundamental relationship between emotion and cognition is by investigating the influence of emotion on the broadening and narrowing of cognitive scope (Derryberry & Tucker, 1994; Easterbrook, 1959; Fredrickson, 2001; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Storbeck et al., 2018). Cognitive scope is an umbrella term for the broadening (‘expansion’) and narrowing (‘retraction’) of various cognitive processes, including cognitive categorisation, memory, time perception, and attentional breadth (Fredrickson, 2001; Fredrickson & Branigan, 2005; Friedman & Förster, 2010; Gable & Harmon-Jones, 2010b; Gable & Poole, 2012; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Isen & Daubman, 1984; Johnson et al., 2010; Price & Harmon-Jones, 2010; Rudd et al., 2012; Threadgill & Gable, 2019b). A classic example of how the broadening and narrowing of time perception can be understood is with the saying ‘time flies when you’re having fun’, which suggests that when an individual experiences joy their perception of time is shortened or becomes narrow.

Regarding the relationship between emotion and cognitive scope, the most widely studied cognitive process is attentional breadth. Attentional breadth is the spatial extent of the

area over which visual attentional resources are applied (Eriksen & St. James, 1986; Goodhew, 2020). Attentional resources can either be spread broadly, for example when scanning for hazards while driving, or they can be spread narrowly, for example when reading the text on this page. Changes in attentional breadth are important for basic visual processes such as spatial and temporal acuity (Lawrence et al., 2020; Mounts & Edwards, 2016) and facial recognition (Gao et al., 2011). Further, the broadening of attentional breadth has been linked to drivers' crash risk (Ball et al., 1993; Wood et al., 2012), regulation of mood (Gu et al., 2017), and even creativity (Friedman et al., 2003; Tidikis et al., 2017). Emotion is proposed to influence attentional breadth, for example, it is argued that when a person feels happy their attention broadens, allowing them to take in more information from their surroundings and enabling them to be open to new opportunities (Fredrickson, 2001). However, when a person feels sad their attention narrows, preparing them for oncoming threats (Fredrickson, 2001).

There is a large body of evidence suggesting that emotional experiences affect the broadening and narrowing of attentional breadth, but the underlying element of emotion or motivation which primarily drives this relationship is debated. There are currently three theoretical models that each claim that a singular element of emotion or motivation is the primary driver of attentional breadth. The arousal-based model claims that arousal (experience ranging from calm to aroused) is the primary driver (Easterbrook, 1959), the valence-based model claims it is bipolar valence (experience ranging from unpleasant/negative to pleasant/positive) (Fredrickson, 2001), and the motivational-intensity-based model claims that it is motivational intensity (the strength of urge to avoid or approach) (for reviews, see Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012). The specific claims made by each of the models are outlined in detail in Chapter 7. Understanding the true driver of cognitive broadening and narrowing was a fundamental aim of this thesis. However, a deeper

understanding of what motivational intensity is and how it relates to arousal and valence was needed before this question could be explored in greater depth.

Chapter 2: Understanding Emotion and Motivation and their Measurement

2.1 Chapter Rationale

Early theoretical accounts suggested that either arousal (your experience ranging from calm to excited/agitated) or valence (your experience ranging from unpleasant/negative) to pleasant/positive) is the primary driver of the broadening and narrowing of cognitive scope (Easterbrook, 1959; Fredrickson, 2001). Cognitive scope is an umbrella term for the broadening and narrowing of various cognitive processes, including cognitive categorisation, memory, thought-action, and attention (Easterbrook, 1959; Fredrickson & Branigan, 2005). However, more recent work posits that motivational intensity (the strength of tendency to approach or avoid) or motivational direction (strength of tendency to approach or avoid) is the main driver of the broadening and narrowing of cognitive scope (for reviews, see Gable & Harmon-Jones, 2010d; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012). Importantly, although some theorists have assumed that a motivation-based dimension drives cognitive broadening and narrowing (Gable & Harmon-Jones, 2010d), current literature does not clearly state whether these motivational dimensions are distinct from arousal or valence. Before it can be assessed which (if any) of arousal, valence, or motivation-based dimensions is the main driver of cognitive broadening and narrowing, it needs to be determined if the newly proposed determinants of cognitive processes, namely motivational intensity and motivational direction, are distinct from the existing and well-understood constructs arousal and valence, and if so, how they can be dissociated from them. The current Chapter will discuss the conceptualisation and operationalisation of arousal, valence, motivational intensity and motivational direction. Chapter 5 will discuss the cognitive processes that are proposed to be driven by arousal, valence, and motivation-based dimensions. Chapter 6 will include a review of the theoretical models that make predictions about the relationship between emotion, motivation, and cognitive broadening and narrowing.

2.2 Theoretical Models of the Conceptualisation of Emotion

There are two core models that capture the way researchers understand emotion: the dimensional model (Russell, 1980; Russell & Carroll, 1999) and the discrete or categorical model (Ekman, 1992b; Ekman, 2003; Izard, 1992). Each of these models is discussed in turn below.

The dimensional model of emotion states that emotions can be conceptualised according to where they fall along fundamental dimensions, typically valence (experience ranging from unpleasant to pleasant; Russell, 1980) and arousal/intensity (experience ranging from calm to excited/agitated; Bradley et al., 2007). Valence has traditionally been conceptualised as a bipolar dimension ranging from negative to positive with neutral in between (Russell, 1980; Russell & Carroll, 1999). However, more recent work challenges the bipolar structure and suggests it is more appropriate to conceptualise and measure valence along two unipolar dimensions (Kron et al., 2013). This issue is discussed and assessed in Chapter 3 and Chapter 4. For now, it is important to identify that valence represents the pleasantness aspect of emotion.

The structure of arousal is typically understood to be unipolar (a singular scale ranging from low to high, or from calm to excited/agitated) (Bradley et al., 2007). When a diverse range of emotional stimuli are plotted by bipolar valence (x-axis) and arousal (y-axis) it creates a U-shape (e.g., Lang et al., 2008), as illustrated in Figure 2.1 using an array of emotional picture stimuli. Typically, strong positive and negative-valence emotional stimuli are highly arousing (e.g., pictures of erotica, threatening scenes, or mutilated bodies), and neutral-valence emotional stimuli are lowest in arousal (e.g., pictures of rocks, mushrooms, and park benches). Emotions of moderate valence and moderate arousal can also be experienced and can be plotted between the neutral point and extremes of valence and arousal. For example, some emotional

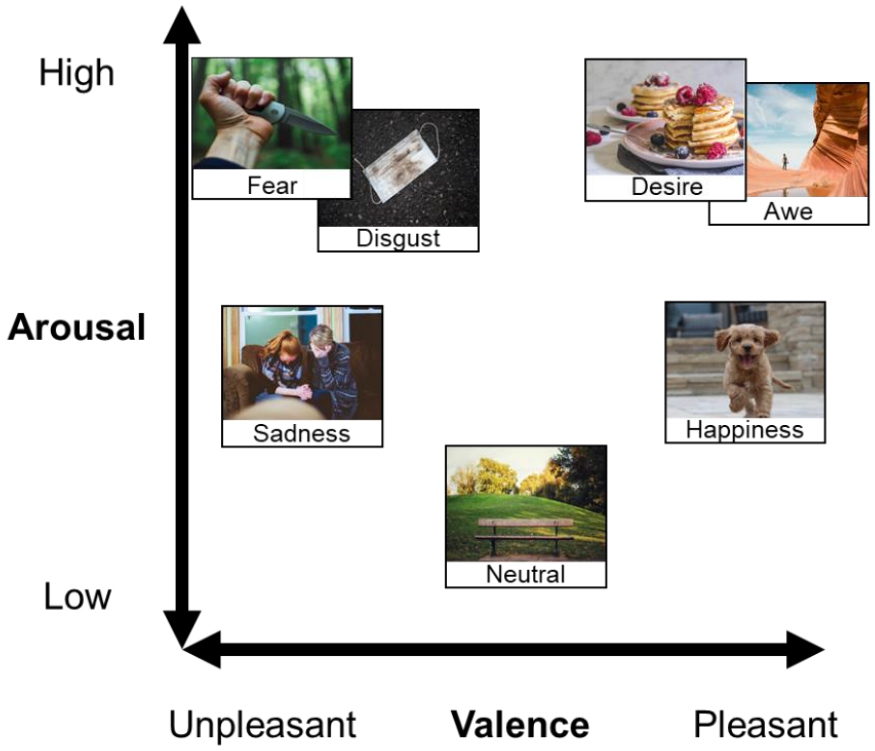
stimuli that are unpleasant (e.g., pictures of homeless people, hurt animals, and crying children) and some that are pleasant (e.g., pictures of puppies and kittens) are moderately arousing.

Discrete model of emotion theorists propose that emotions exist as distinct entities, which are often referred to as basic emotions (Ekman, 1992a, 1992b; Ekman, 2003; Izard, 1992). Prominent discrete emotion theorist originally proposed seven basic emotions, namely: joy, surprise, fear, sadness, anger, contempt, and disgust, but later removed contempt from this list making it six basic emotions (Ekman, 1992b). Of course, there are other discrete emotions that are explored in emotion research, which include amusement, awe, desire, contentment, and so on (for a review, see Keltner et al., 2019). However, it is proposed that the six basic emotions are innate and experienced universally (Ekman, 1992a). More broadly, the discrete approach to emotion treats emotions as belonging to categories, rather than as points along dimensions.

The dimensional and discrete models of emotion are frequently seen as opposing, and there is considerable discussion in the literature concerning this debate (Izard, 2007; Panksepp, 2007). A combination of dimensional and discrete models of emotion may allow for a greater understanding of the complexities and utilities of emotions (see Harmon-Jones, 2019; Harmon-Jones et al., 2017 for reviews). Discrete emotions may exist as entities that sit within the bounds of the dimensions of emotion, arousal and valence, considering dimensional and discrete aspects of emotion tell us something that one or the other cannot on their own. For example, both fear and disgust evoke negative valence and high arousal but may have quite distinct sensory and attentional consequences (e.g., Perone et al., 2020; Susskind et al., 2008). Moreover, dimensions of arousal and valence predict significant magnetoencephalography (MEG) neural representations, whereas only some discrete emotions (fear, disgust, and happiness) are quickly represented by the brain (Grootswagers et al., 2020). Discrete emotions can also sit differently on the arousal and valence dimensions, for example, sadness evokes negative valence, but moderate arousal (Mikels et al., 2005). It may also be that ratings of

dimensions of arousal and valence can tell us information that ratings on discrete emotions cannot. For example, within discrete emotion categories (e.g., sadness), there may be different degrees of valence and arousal (e.g., exhibited from grief and helplessness), which is not captured if you focus exclusively on discrete emotions. See Figure 2.1 for an illustration of how some other discrete entities of emotion alongside happiness and fear may map onto existing dimensions of emotion, arousal and valence.

Figure 2.1 *Illustrated Demonstration of Bipolar Valence Plotted Against Unipolar Arousal with Some Commonly Experienced Discrete Emotions and Example Picture Stimuli Mapped onto the Dimensions*



Note. Pictures shown here are not used in this thesis or in picture databases (e.g., International Affective Picture System (IAPS)) as to protect the pictures used as research tools. Each picture here is from the Internet and is used to represent the specific discrete emotions listed: fear (https://unsplash.com/photos/RUe01V7ECGI); disgust (https://unsplash.com/photos/VBgDR6aHB3E); sadness (https://unsplash.com/photos/e92L8PwcHD4); neutral (https://unsplash.com/photos/V4Q9cqeashY); happiness (https://unsplash.com/photos/wxfZi8eYdEk); desire (https://unsplash.com/photos/Zt-0gWKodXk); and, awe (https://unsplash.com/photos/cvw75oY6Mjc).

2.3 Methodology for Inducing and Measuring Emotions

2.3.1 Inducing Emotions

Numerous methods are used to experimentally induce emotions in the laboratory. These methods include presenting emotionally-evocative pictures, presenting emotionally-evocative music, memory recall of emotionally-evocative events in the participant's life, and vignettes of hypothetical scenarios. Depending on the intended emotional induction, different methods are found to be more effective in inducing a specific emotional state (see Siedlecka & Denson, 2018 for a review).

In the current thesis, pictures were used to evoke emotions. Pictures were chosen for a number of reasons, including that this approach was consistent with the vast majority of the literature on motivational intensity and its effect on cognition (e.g., Domachowska et al., 2016; Gable & Harmon-Jones, 2008a, 2010a, 2010b, 2010c, 2011b, 2013; Gable et al., 2015; Harmon-Jones & Gable, 2009; Harmon-Jones et al., 2011a; Threadgill & Gable, 2019b), meaning that results would be directly comparable with previous research. Further, this approach has the advantage of allowing a wide range of stimuli to be used to elicit specific levels of valence or motivation, or discrete categories of emotion. The use of large sets of pictures helps to ensure that results are due to the intended underlying emotion, rather than any reaction idiosyncratic to a particular stimulus. While some recent research has sought to use dynamic visual stimuli (e.g., films; Kaczmarek et al., 2021), one disadvantage of this approach is that practically it often means that one or only a small number of stimuli can be used as inducers, (a) because of the much longer time taken to present a film compared with a picture, and (b) because there are not widely-used databases with many diverse films validated as inducing those emotions. Another advantage of the use of static stimuli is that it means that their physical parameters (e.g., colour, size, number of objects) can be controlled. In other words, it is possible to match stimuli across affective-prime conditions on such physical

parameters, which is useful when seeking to isolate the influence of affect inductions (separate from visual effects) on psychological processes.

Another advantage of using emotional pictures to induce emotions is that there are a number of large databases of pictures that have been validated via both rating and objective physiological measures to induce emotions (e.g., Kurdi et al., 2017; Lang et al., 2008; Marchewka et al., 2014; Wierzba et al., 2015). Specifically, the International Affective Picture System (IAPS) (Lang et al., 2008) is a widely-used picture database, with pictures that represent a diverse range of situations, places, faces, and objects. The pictures are intended to span the full range of emotions from highly unpleasant and arousing pictures (e.g., mutilated bodies, attacks, threatening animals) to highly pleasant and arousing pictures (e.g., erotica and desserts). The IAPS pictures have also been classified by discrete emotions (e.g., awe, amusement, happiness, disgust, and sadness; Mikels et al., 2005). Although the IAPS covers a wide range of picture stimuli that represent an array of human experiences, there are some experiences that are not widely represented in the IAPS (e.g., the discrete emotion anger). In addition to existing databases, the Internet is a useful tool for gathering emotional picture stimuli to represent population specific situations. For example, one previous study used pictures of American flag burnings to evoke anger in an American population (Gable et al., 2015). For this thesis, the choice was made to collect picture stimuli from picture databases (e.g., the IAPS) and supplemented picture selection from the Internet where needed to induce the full range of intended emotions.

2.3.2 Measuring Emotions

There are a variety of techniques that can be used to measure emotions in the laboratory. These methods include, physiological measures such as facial electromyographic (EMG), heat conductance, pupil dilation, and heart rate (e.g., Bradley & Lang, 2007a; Bradley et al., 2008; Lang et al., 1993). However, for the current body of work, subjective ratings were used to

operationalise emotion. Subjective ratings were chosen because this measurement tool for emotion is consistently used when examining the impact of emotion on cognitive processes (Gable & Harmon-Jones, 2008a, 2010a; Gable et al., 2016; Gable & Poole, 2012; Gable et al., 2015; Rowe et al., 2007). When subjective ratings are used, people are asked to rate their emotional experience while viewing the emotional stimuli. Subjective ratings can be collected on scales that represent different dimensions of emotion, for example, bipolar valence (ranging from unpleasant to pleasant) (Russell, 1980) or unipolar arousal (ranging from calm to excited/agitated) (Bradley & Lang, 2007a). Subjective ratings of degrees of discrete emotions (e.g., strength of fear experienced) may also be collected (e.g., ranging from no fear to extreme fear). As discussed in the above section, the IAPS has a wide collection of emotional picture stimuli, and each IAPS picture has had subjective ratings of valence and arousal collected across a number of populations (e.g., ages, cultures, and sexes; Bradley, Codispoti, Sabatinelli, et al., 2001; Grühn & Scheibe, 2008; Huang et al., 2015).

Another method used to measure emotional experiences in response to pictures are physiological measures. Studies have used physiological measures to validate subjective changes in arousal and valence while viewing picture stimuli (e.g., Bradley, Codispoti, Cuthbert, et al., 2001; Bradley, Codispoti, Sabatinelli, et al., 2001; Lang et al., 1993; Larsen et al., 2003). For example, an increase in subjective arousal during picture viewing has been linked to an increase in cardiac response and pupil dilation (Bradley, Codispoti, Cuthbert, et al., 2001; Bradley, Codispoti, Sabatinelli, et al., 2001; Bradley et al., 2008). Similarly, an increase in subjective negative valence experienced while viewing disgusting pictures has been validated by facial EMG studies via changes to associated facial muscles such as those used during frowning (Lang et al., 1993; Larsen et al., 2003).

Physiological measures are helpful for providing an index of how psychological processes map onto physical changes. However, subjective measures (i.e., ratings) are an

important starting point for measuring emotions and how they manifest according to individuals. Without subjective ratings, it is difficult to understand how physiological responses are related to emotional experiences. For example, heart rate may increase when we encounter a coiled snake, but without a subjective explanation of the feelings associated with the situation, it would not be possible to relate an increase in heart rate to the feeling (e.g., fear) associated with the experience (e.g., coiled snake). If individuals are asked how they feel during various emotionally-evocative experiences (e.g., when they encounter a coiled snake or a cute baby), any physiological reactions may then be able to be related to the emotional experience (e.g., a coiled snake may evoke fear and a cute baby may evoke happiness). It is important that subjective ratings are collected first, like was done with the IAPS, and then subjective ratings can be validated by physiological measures.

Emotional experiences can also be measured implicitly via response time measures. Response time measures may give an indication of the emotional intensity of the experience. For example, a faster response time to classify a stimulus as positive or negative may represent a more intense emotional response, and a slower response time may represent a less intense emotional response.

2.4 Conceptualising the Motivational Dimensional Model of Affect

The purpose of this section is to discuss how motivational intensity is contextualised in the literature. The motivational dimensional model of affect argues that motivational intensity (the strength of motivational tendency to approach or avoid), rather than arousal or valence, is the primary driver of cognitive broadening and narrowing (Gable & Harmon-Jones, 2010d). However, some questions remain: what is motivational intensity, how is it conceptualised, and how is it related to well-understood dimensions of emotion, arousal, and valence?

The model argues that there are two ways to understand motivation. First, that motivation can be understood in terms of its **direction**, which is the **tendency to approach or**

avoid. Second, in terms of its **intensity**, which is **the strength (low-high) of the tendency to approach or avoid** (for reviews, see Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012). Motivational direction can differ, for example, when desire and disgust are evoked. During desire, an individual may feel an urge to approach the desirable stimuli (e.g., dessert) (Gable & Harmon-Jones, 2008a). Whereas during disgust, individuals may feel an urge to move away from or avoid the disgusting stimulus (e.g., a used face mask) (Gable & Harmon-Jones, 2010a). Emotions can also differ in their motivational intensity. Motivational intensity is proposed to differ, for example, during sadness and fear. It is argued that sadness evokes less intense motivation than fear because the evoked tendency to act is weaker during sadness (e.g., a hurt animal). However, during fear, it is argued that a stronger urge to act is evoked (e.g., when experiencing threat) than that evoked during sadness (Gable & Harmon-Jones, 2010a). Further, to our awareness, there is no existing empirical work in the literature that examines the structure of motivational intensity. That is, whether it exists as a single bipolar dimension (ranging from avoid-approach) or as two unipolar dimensions (one which ranges from low-high on avoidance and a separate dimension for approach). In Chapters 3 and 4 of this thesis, the first empirical assessment of the structure of motivational intensity is provided.

2.4.1 Motivational Intensity and Arousal

A review of the literature indicates that the overall conceptualisation of motivational intensity warrants clarification, and the lack of clear differentiation from other existing constructs of emotion poses some intriguing questions. First, is motivational intensity a distinct entity from the well-understood arousal and valence? Or is motivational intensity merely arousal or valence by another name? The motivational dimensional model of affect proposes that motivational intensity is linked directly to arousal, but that it also exists distinctly from arousal because motivation involves an urge to act, and arousal does not (see, Gable & Harmon-

Jones, 2013 for a discussion). The model suggests that an increase in motivational intensity triggers the same response observed when arousal increases, including an increase in subjective arousal levels, and in the activation of the sympathetic nervous system (Gable & Harmon-Jones, 2010c). The motivational intensity model also states that these two constructs are so closely related that it is appropriate (in most cases) to use arousal as a proxy for motivational intensity. Previous conceptual and empirical work argues there are some instances where arousal may not be an appropriate proxy for motivational intensity (Gable & Harmon-Jones, 2008a, 2013). Specifically, the discrete emotion amusement has been used as an example to demonstrate how motivational intensity separates from arousal (Gable & Harmon-Jones, 2008a). One claim is that amusement evokes low motivational intensity, despite its high arousal levels (Gable & Harmon-Jones, 2008a, 2013). The proponents of motivational intensity propose that this divergence may occur for example, when an individual witnesses a performance of slap-stick comedy, where it is proposed that although an individual may experience subjective arousal during the amusing experience, their tendency to act may be low because they may not wish to move towards or away from the situation causing the amusing response (Gable & Harmon-Jones, 2008a). Further, the model posits that although amusement and desire are both positively-valenced highly arousing states, they differ in their respective low and high motivational intensities (Gable & Harmon-Jones, 2008a), because amusement (e.g., slap-stick comedy) evokes a lower urge to act than is evoked during desire (e.g., when an individual is given the opportunity to eat chocolate). Therefore, according to conceptualisations within the literature, motivational intensity and arousal do not always converge, but the proponents have suggested that arousal is an appropriate proxy for motivational intensity in most cases, implying a high degree of correspondence between the two constructs.

2.4.2 Motivational Intensity and Valence

Although previous theorists suggest a strong correspondence between approach and avoidance motivation and positive and negative valence, respectively (e.g., Lang, 1995; Watson, 2000), proponents of motivational intensity theory claim motivational intensity and valence are distinct (Gable & Harmon-Jones, 2010d). The distinction between motivational intensity and valence is argued for on the basis that individuals may sometimes want to approach experiences that make them feel negative and avoid experiences that make them feel positive (Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013). Often the discrete emotion anger is used as an example of how approach/avoidance motivation diverges from positive/negative valence, respectively (for a review, see Carver & Harmon-Jones, 2009). Specifically, it has been suggested that anger is a negatively-valenced state that may evoke approach motivation. It is suggested for example that when an individual feels angry during an argument with another person, they may feel an urge to approach to engage in confrontation, despite the negative valence the situation evokes. Some studies have explored avoidance motivation associated with anger (e.g., Zinner et al., 2008), however a collection of conceptual and empirical studies have proposed that anger is approach-motivated (e.g., Carver, 2004; Gable et al., 2016; Gable et al., 2015). Altogether, there is not a consensus view of the association between motivational intensity and valence in the literature, and much of what has been proposed has relied on assumptions rather than direct testing. Therefore, one of the goals of the work carried out as part of this thesis was to test the relationship between motivational intensity and valence directly and systematically.

2.5 Methodology for Inducing and Measuring Motivational Intensity

2.5.1 Inducing Motivational Intensity

There are numerous ways that motivation is currently induced in the literature. Like inducing emotion, one common way to induce motivational intensity is via the presentation of

pictures intended to elicit different motivational intensities. For example, a picture of a delicious dessert is thought to evoke stronger motivation to approach than a picture of a rock. Sometimes inductions of motivational intensity also include additional elements, such as the instruction that participants will be consuming the desserts shown in the picture. Specifically, the expectation to consume the viewed desserts is thought to enhance their induced motivational intensity (e.g., Gable & Harmon-Jones, 2008a, Study 4).

Another way is via introducing the expectation that the participant will engage in an angry confrontation (Gable & Harmon-Jones, 2008a; Harmon-Jones et al., 2006). For example, it was argued that telling participants they were going to be engaging in an anger-inducing interaction would increase their approach motivation (Harmon-Jones et al., 2006). It is also acknowledged that the tendency to approach or avoid may vary depending on the specific individual (e.g., Gable & Harmon-Jones, 2008a, 2008b; Gable & Poole, 2014; Harmon-Jones, 2003). In fact, trait variables have also been used to induce motivational intensity (e.g., Gable & Harmon-Jones, 2008a; Gable & Poole, 2014; Harmon-Jones, 2003, 2007). For example, one study used trait behavioural approach system/behavioural inhibition system (BAS/BIS) to enhance participants approach motivation towards appetitive stimuli (Gable & Harmon-Jones, 2008a). These studies associate approach motivation with BAS (Fowles, 1987), and avoidance motivation with BIS (Gray, 1970). Carver and White (1994) developed a scale intended to measure individual differences in trait qualities to the BAS and BIS systems. Studies have used this scale, for example, to accordingly link trait BAS to anger (e.g., Gable & Poole, 2014).

Previous studies supporting the motivational dimensional model of affect have also used embodied cognition to operationalise differing strengths of approach motivation (Harmon-Jones & Peterson, 2009; Price & Harmon-Jones, 2010). One study (Price & Harmon-Jones, 2010) had participants smile during three various body postures intended to induce differing levels of approach motivational intensity (e.g., reclined = low approach; up right =

neutral; and, leaning forward = high approach). Another study also induced leaning forward body postures, which they claimed predicted greater left frontal cortical activation compared to induced reclining body postures (Price & Harmon-Jones, 2011).

Other motivational induction techniques include essay writing and watching short films (Gable & Harmon-Jones, 2008a; Gable et al., 2016; Kaczmarek et al., 2021). For instance, during essay writing activities participants are instructed to write about personally important issues when given motivational cues (e.g., think about a recent sad experience where you felt a strong urge to do something; Gable et al., 2016). Films have also been used to induce motivational states (Gable & Harmon-Jones, 2008a; Gable et al., 2016; Kaczmarek et al., 2021). For example, a particular discrete emotion may be targeted (e.g., awe) and participants are asked to indicate their dynamic motivational response over time (Kaczmarek et al., 2021), or researchers have assumed that the films used evoke a particular motivational state when used in inductions (e.g., approach motivation; Gable & Harmon-Jones, 2008a; Gable et al., 2016).

For several reasons, in Chapter 3 and 4, and 6 pictures were selected as the method of induction for motivational intensity. Firstly, in Chapter 3 and 4 the picture approach was chosen because it was the most widely-used method of motivational intensity induction in previous studies assessing motivational intensities effect on cognition (e.g., Domachowska et al., 2016; Gable & Harmon-Jones, 2008a, 2010a, 2010b, 2010c, 2011b, 2013; Gable et al., 2015; Harmon-Jones & Gable, 2009; Harmon-Jones et al., 2011a; Threadgill & Gable, 2019b), meaning that the new data could be compared against existing conclusions made in this space. Therefore, the new new motivational intensity rating data could be compared against existing and new emotion data. Moreover, because pictures are widely accessible through databases and the Internet, a wide range of picture stimuli that represented an array of motivational experiences could be accessed using this method. In addition, for the work described in Chapter

6, using pictures allows for physical parameters to be controlled (e.g., size, colour, number of objects), allowing for motivational effects to be isolated from visual effects when examining their effects on cognitive processes. Finally, it would be beneficial to use the same induction process to concurrently examine both traditional dimensions of emotion (e.g., valence), as well as motivational intensity. Since approaches such as an embodied cognition inductions are thought only to produces changes in motivational intensity, not valence or arousal, this would make them unsuitable for direct comparison between the motivational intensity and valence resulting from the same induction. In contrast, since pictures have been shown to produce changes in emotion and are thought to produce changes in motivational intensity as well, they were ideal for the present work.

2.5.2 Measuring Motivational Intensity

Studies have used a handful of methodologies to operationalise motivational intensity that do appear to rely on untested assumption. As mentioned when outlining the conceptualisation of motivational intensity, the motivational dimensional model of affect posits that motivational intensity is distinct from arousal (Gable & Harmon-Jones, 2010a; Harmon-Jones et al., 2013), but that motivational intensity and arousal are so closely related that it is suitable to use arousal as a proxy for it (Gable & Harmon-Jones, 2010a; Gable & Poole, 2012; Harmon-Jones, Gable, et al., 2012; Threadgill & Gable, 2019b). That is, in previous studies, stimuli have been selected based on their normative arousal ratings (e.g., from the IAPS) to represent levels of motivational intensity (e.g., low motivational intensity = low arousal; Gable & Harmon-Jones, 2008a; Gable & Harmon-Jones, 2010c; Harmon-Jones et al., 2011b). Previous studies have also had participants rate stimuli on their arousal levels and used these ratings as indications of motivational intensity levels (Gable & Harmon-Jones, 2008a, 2008b; Gable & Harmon-Jones, 2009; Gable & Harmon-Jones, 2010c, 2011a). However, this is predicated on a previously untested assumption about the degree of correspondence between

motivational intensity and arousal, which lacks rigorous justification. In Chapter 3, the assumption about the high degree of correspondence between motivational intensity and arousal was examined. To do so, however required motivational intensity to be able to be measured separately from arousal. Therefore, other ways of measuring motivational intensity need to be considered.

Another common method used to measure motivational intensity is through the collection of self-reported experiences of discrete emotions (e.g., self-reported disgust). Assumptions are then made about how discrete emotions relate to motivational intensity (e.g., high self-reported sadness = low motivational intensity, high self-reported disgust = high motivational intensity; Gable & Harmon-Jones, 2010a). While these assumptions have face validity, traditionally they have not been validated empirically (Gable & Harmon-Jones, 2008a, 2008b, 2010a, 2010c; Harmon-Jones & Gable, 2009), with some more recent exceptions (Kaczmarek et al., 2021). Empirically establishing the relationship between different discrete emotions and the motivational intensities that they elicit is essential for this to be an appropriate approach to inducing and measuring motivational intensity. In Chapter 4, the motivational intensity of a range of discrete emotions was systemically tested.

Further, some studies have used differences in subjective ratings of valence between conditions as an indicator that they differ with respect to their motivational intensity (e.g., Gable & Harmon-Jones, 2008a, 2010a; Threadgill & Gable, 2019b). This seems particularly problematic given these proponents' assertion that motivational intensity is distinct from valence. It is also curious that in these studies, observed behavioural effects on cognition are attributed to motivational intensity and not valence. In fact, motivational intensity is explicitly proposed to supersede valence as a driver of cognitive scope, despite the only demonstrated difference between the conditions being on valence, rather than motivational intensity. Again, using differences in valence ratings between conditions as an indicator of motivational intensity

highlights the need for a systematic study comparing how motivational intensity converges with or diverges from valence.

Some studies have used behavioural measures of motivational intensity. For example, in some studies, participants are asked to judge whether a stimulus is positive or negative by either pushing or pulling a lever or joystick. Faster *pull* responses are taken as indicative of approach motivation, while faster *push* responses are taken as indicative of avoidance motivation (Chen & Bargh, 1999). This approach does not rely on self-reports of motivational intensity, and therefore can circumvent issues such as participants being unaware of their motivation or wanting to hide it (Krieglmeyer & Deutsch, 2010). However, it does rely on the assumption that the speed of these different motor actions provides a valid quantification of motivational intensity. Such an assumption is difficult to test without also collecting information on participants' self-reported motivational intensity.

Another metric that has been suggested to reflect motivational intensity is asymmetrical frontal cortical activity, which is measured via electroencephalogram (EEG), and late positive potentials (LPP) (Harmon-Jones & Gable, 2018; Harmon-Jones et al., 2010). It should be noted that the relationship between alpha asymmetry and motivational intensity is highly speculative, and hence, suggested by only a few studies from Harmon-Jones et al.'s work, and even this work relies on some questionable assumptions, as I discuss below. First, however, I will outline the tenets of this approach. The motivational intensity model of asymmetrical cortical frontal activity proposes that activation of the left frontal cortical area is related to approach motivation, and activation of the right frontal cortical area is related to avoidance motivation (Harmon-Jones & Gable, 2018; Harmon-Jones et al., 2010). Here, logic stems from the original idea that positive and negative valence are related to left and right frontal cortical activation, respectively (Gainotti, 1972; Robinson & Price, 1982). However, the motivational intensity model claims that motivational intensity, rather than valence is responsible for any relative

activation observed in previous studies (for reviews, see Harmon-Jones & Gable, 2018; Harmon-Jones et al., 2010). In the literature, the discrete emotion anger is used to demonstrate how motivational intensity, rather than valence may be responsible for changes in cortical activity. As mentioned in the above section, motivational intensity theorists propose that anger is an approach motivated state, despite its negative valence (e.g., Carver & Harmon-Jones, 2009; Gable & Poole, 2014; Gable et al., 2015; Harmon-Jones, 2003, 2007; Harmon-Jones & Allen, 1998; Harmon-Jones et al., 2006). However, as discussed above, this assumption about the link between this discrete emotion and its associated motivational intensity has not been extensively directly tested, and indeed in some cases when participants are explicitly asked about their motivation following anger induction, they have been found to report avoidance motivation (Gable et al., 2015).

Studies that have explored motivational intensity and frontal cortical activity rely on the assumption that anger is associated with approach motivation, and hence left frontal cortical activity (e.g., Harmon-Jones, 2007; Harmon-Jones et al., 2006; Zinner et al., 2008). Sometimes manipulation checks are included to show that participants did experience anger in these studies. However, showing that anger is linked to left frontal activity do not provide validation for a connection between left frontal cortical activity and approach motivation. None of the relevant empirical studies exploring asymmetrical cortical activity and anger have connected their operationalisation of motivational intensity to a subjective measure of motivation. Therefore, even if left frontal activity is associated with anger, this does not necessarily imply it is associated with approach motivation. It should have been a prerequisite that subjective ratings of motivational intensity were validated by left and right frontal cortical activation. As a result, it cannot be concluded that, in the studies exploring motivational intensity and frontal cortical activity, motivational intensity was even elicited during the inductions, and hence further empirical evidence is needed to support this idea.

Associating anger with approach motivation is problematic because there may be reason to question that anger is solely approach motivated. For example, individuals may experience anger differently, and some people may experience avoidance motivation during angry situations that are intended to evoke approach motivation. If so, the logic of these situations, which evoke anger activating approach motivation, and therefore left frontal cortical activity should be questioned as well. Another issue with associating anger with approach motivation is that even though anger may have approach motivation attributes (Carver & Harmon-Jones, 2009; Harmon-Jones, 2003; Harmon-Jones & Allen, 1998), it has many other attributes as well (e.g., leads to an increase in impulsivity). Therefore, it is difficult to attribute the left frontal cortical EEG activity just to approach motivation, as opposed to something more specific about anger (e.g., impulsivity).

Despite a long tradition of using well-validated reports of subjective experiences of valence and arousal to operationalise dimensions of emotion, the proponents of motivational intensity have not embraced this approach when it comes to motivation (e.g., they typically have not used a scale where subjective experiences of motivation can be measured). Moreover, they have not assessed if the newly proposed construct motivational intensity exists distinct from arousal or valence. Where a small number of studies have collected subjective ratings of motivational intensity at all, it has only been for a subset of stimuli (e.g., sad or angry stimuli only; Gable et al., 2016; Gable et al., 2015). However, it is possible that these ratings may be impacted by the truncated range of emotional stimuli available for participants to rate. Rather than assessing the motivational tendencies of a subset of emotional stimuli, they should have conducted a study where they collected ratings of motivational intensity and compared those ratings to those of arousal and valence for a large swathe of stimuli to determine their level of association. Overall, the key foundational work needed to differentiate motivational intensity from arousal and valence is currently missing. Therefore, this was the aim of the empirical

work carried out in Chapter 3 and 4, to ultimately determine if motivational intensity is distinct from arousal and valence, and if so in what way.

2.6 Chapter Executive Summary

The current Chapter outlined various methods used to induce and measure emotion and motivational intensity. For the empirical work in this thesis, pictures were used to induce emotion and motivational intensity, and subjective ratings were primarily used to measure emotion and motivational intensity.

Chapter 3: Does Motivational Intensity Exist Distinct from Valence and Arousal?

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3.1 Abstract

The motivational intensity model proposes that the strength of one's urge to approach or avoid a stimulus is the primary driver of cognitive broadening/narrowing (Gable & Harmon-Jones, 2010d; Harmon-Jones, Gable, et al., 2012). However, it is unclear whether motivational intensity is truly distinct from well-established dimensions of valence and arousal. Here we found an overwhelmingly strong relationship between motivational intensity and valence across all studies. In Study 1, we operationalised motivational intensity on two response rating scales and had multiple groups of participants (total 150) rate their response of motivational intensity, valence, and arousal to 300 pictures. There was a very strong relationship between motivational intensity and valence (r_s in excess of .9, in studies 1a and 1b), which challenges the idea that these two constructs are distinct. In contrast, motivational intensity ratings were not consistently positively related to arousal ratings, with only a moderate relationship found with avoidance motivation. In Study 2 we used an implicit measure of motivational intensity and valence and asked participants to classify their motivational intensity and valence in response to 100 pictures from Study 1. A high degree of correspondence was found between motivational intensity and valence on this measure. Overall, our findings are at odds with proposals in the literature that arousal can be used as a proxy for motivational intensity across the full approach-avoidance spectrum. Furthermore, these studies suggest that the cognitive effects attributed to motivational intensity in previous literature are best explained by valence.

Keywords: valence; arousal; motivational intensity; approach; avoidance.

3.2 Introduction

The factors that drive cognitive processes have been the subject of psychological research for over 50 years. Several key theories argue emotions have a key role to play in the broadening/narrowing of cognitive scope (for a review, see Harmon-Jones, Gable, et al., 2012). Here we use cognitive scope as an umbrella term to cover multiple cognitive processes (e.g., attentional breadth, memory, time perception, cognitive categorization, and visual perception; (e.g., Fredrickson, 1998; Fredrickson & Branigan, 2005; Rowe et al., 2007). Proposals include that negative emotions narrow cognitive scope (Finucane, 2011) and positive emotions broaden cognitive scope (Fredrickson, 1998; Fredrickson & Branigan, 2005). These theories focus on the dimension of valence. That is, an individual's subjective experience ranging from unpleasant/negative to pleasant/positive. More recently however, the motivational intensity model has been proposed as an alternative dimension that might better explain the changes that occur in cognitive processing under different emotional conditions (e.g., Gable & Harmon-Jones, 2010a, 2010d; Harmon-Jones & Gable, 2008; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013). Motivational intensity is defined as the strength of urge to move towards or away from a stimulus (Harmon-Jones, Price, et al., 2012). Proponents of this model claim that previous studies focused on valence exclusively examined positive emotions low in motivational intensity (e.g., contentment and amusement) and negative emotions high in motivational intensity (e.g., disgust), and that the distinguishable cognitive outcomes from these different-valence conditions can therefore be attributed to confounding differences in the motivational intensity instead of valence (Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a, 2010a). The main claim of the motivational intensity account of cognitive processing is that high motivational intensity—irrespective of whether the urge is to approach or avoid—narrows cognitive scope (for reviews, see Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013). The broadening and narrowing of cognitive scope may occur at

many levels. It has measured by the broadening and narrowing of attentional breadth, memory, time perception, cognitive categorisation, and visual perception (Gable & Harmon-Jones, 2010a, 2010d; Gable & Poole, 2012; Rowe et al., 2007; Threadgill & Gable, 2019b). This idea derives from functional arguments. For example, if a person feels a strong desire to approach a stimulus (e.g., a dessert) then it makes sense that they should narrow their attentional focus (one measure of cognitive scope) to 'zero in' on pursuing the dessert. Alternatively, if a person feels a strong desire to avoid a stimulus (e.g., a snake) then focusing narrowly on it could facilitate that avoidance. In contrast, when an individual feels contentment (e.g., after consuming a dessert), they no longer have a strong goal or urge to act, and accordingly their attentional breadth would broaden.

While this idea has strong intuitive appeal, the literature is unclear about how motivational intensity should be operationalised. For example, it is suggested that arousal is an appropriate rough proxy for motivational intensity (e.g., Gable & Harmon-Jones, 2008a, 2010a, 2013). However, the extent to which motivational intensity is distinct from other established dimensions, such as valence and arousal, is questionable. This is important because a pre-requisite for motivational intensity to have additional explanatory power is that it needs to be distinct from established dimensions. Here, we examine two alternative ways of operationalising motivational intensity using rating scales that ask people explicitly about their urge to approach or avoid. We then measure motivational intensity implicitly using an RT-based measure. Both types of tasks are used to test whether motivational intensity is truly something distinct from valence and arousal.

3.3 The Valence-Arousal Model of Emotions, and Cognitive Processing

The architecture of emotion is conceptualised as consisting of two key dimensions: valence and arousal (Bradley & Lang, 2007a; Russell, 1980). Valence is conceived of as varying from unpleasant/negative to pleasant/positive via a neutral midpoint, and arousal as

varying from low (e.g., calm) to high (e.g., excited/agitated). These dimensions are dissociable, though not entirely independent. That is, emotions with extreme valences, either positive or negative, score higher in arousal, producing a U-shaped function when elicited emotions are plotted as a function of valence (x-axis) and arousal (y-axis).

There is a long history of theories using these two dimensions to explain the relationship between emotions and a number of cognitive processes. People's experience of emotion has demonstrated associations with a variety of cognitive processes, including attentional breadth and visual perception (e.g., Easterbrook, 1959; Finucane, 2011; Finucane & Power, 2010; Fredrickson & Branigan, 2005; Friedman & Förster, 2010; Johnson et al., 2010). Some early theoretical accounts proposed that emotional arousal narrows cognitive scope (Easterbrook, 1959). Others have espoused that all negative-valence emotional states narrow cognitive scope (Finucane, 2011; Finucane & Power, 2010). A more recent, popular proposal is the *broaden-and-build hypothesis*, which posits that all positive affective states broaden cognitive scope (Fredrickson, 1998; Fredrickson & Branigan, 2005).

3.4 Motivational Intensity as an Alternative Mediator of Cognitive Processing

Over the last decade, research on emotion and cognitive scope has looked to the motivational intensity model for a potentially better account of observed effects (Gable & Harmon-Jones, 2010a, 2010d; Harmon-Jones & Gable, 2008; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013). For instance, the motivational intensity model has been studied in relation to attentional breadth (e.g., Gable & Harmon-Jones, 2008a, 2010a), which is the spatial area over which attention is deployed (Eriksen & St. James, 1986; Goodhew, 2020). The motivational intensity model predicts that emotions that are positive or negative in valence but high in motivational intensity (e.g., desire = high approach, disgust = high avoid) narrow attentional breadth, and that emotions that are positive or negative valence, but low in motivational intensity (e.g., amusement and sadness = low approach) broaden it (e.g., Gable &

Harmon-Jones, 2008a, 2010a; Harmon-Jones et al., 2013). Here the driver of attentional breadth is the strength of motivational intensity, irrespective of the valence. Indeed, a critical theoretical point is that motivational intensity is claimed to be dissociable from valence (Carver & Harmon-Jones, 2009; Summerell et al., 2019) and arousal (Gable & Harmon-Jones, 2013).

Other studies have measured the impact of emotion on changes of cognitive scope using the broadening and narrowing of memory (e.g., Gable & Harmon-Jones, 2010b; Threadgill & Gable, 2019b) and the shortening and lengthening of time perception (e.g., Gable et al., 2016; Gable & Poole, 2012). For instance, it has been claimed that strong motivational intensity enhances memory for centrally presented targets, and low motivational intensity enhances memory for peripherally presented targets (Threadgill & Gable, 2019b). Motivational intensity is also claimed to be important in explaining the effect of emotion on other cognitive processes, such as cognitive categorization and attentional flexibility (e.g., Ma & Li, 2016; Price & Harmon-Jones, 2010) Altogether, this suggests that motivational intensity models may better explain the observed relationships between emotion and cognitive processes than valence or arousal-based theories.

3.5 Problems with the Operationalisation of Motivational Intensity

Given the theoretical importance of motivational intensity, it is striking that little work has investigated the most appropriate way to operationalise it. Gable and Harmon-Jones have tended to rely on two approaches, both of which lack empirical backing. In some instances, they have recommended using arousal ratings as a proxy for motivational intensity, with higher arousal ratings being indicative of greater motivational intensity (Gable & Harmon-Jones, 2010a; Gable & Poole, 2012). This approach makes an untested assumption about how motivational intensity relates to arousal. It is also somewhat curious to insist that motivational intensity is conceptually distinct from arousal (Gable & Harmon-Jones, 2010a; Harmon-Jones et al., 2013), yet to recommend it as an appropriate method of operationalising the construct

(Gable & Harmon-Jones, 2010a; Gable & Poole, 2012; Harmon-Jones, Gable, et al., 2012; Threadgill & Gable, 2019b).

In other instances, Gable and Harmon-Jones have used ratings of discrete emotions (e.g., level of amusement) to operationalise motivational intensity, based on assumptions about how these discrete emotions relate to motivational intensity (e.g., that amusement = low motivational intensity). These assumptions are based on logical analysis and face validity, but typically lack corroborating evidence (Gable & Harmon-Jones, 2008a, 2008b, 2010a, 2010c; Harmon-Jones & Gable, 2009).

Similar assumptions that lack substantiating evidence pervade the research linking motivational intensity to asymmetries in frontal cortical activation, measured via electroencephalogram (EEG). Early work on frontal cortical activation linked negative and positive emotions with preferential activation of the right and left frontal cortices respectively (Gainotti, 1972; Robinson & Price, 1982). Historically, observed frontal asymmetries have been attributed to the *valence* of emotion experienced. However, proponents of the motivational intensity model argue motivational direction rather than valence drives these asymmetries. That is, that approach motivation (rather than positive valence) leads to preferential left activation (Harmon-Jones & Gable, 2018; Harmon-Jones et al., 2010). The key assumption underlying this reasoning is that anger, despite its negative valence, elicits approach motivation – an assumption that remains minimally tested, and uncorroborated by the evidence obtained.

One emotion often held up as a logical example of motivational intensity disconnecting from valence is anger. Anger is a negative valence emotion that is claimed to be approach-motivated (for a review, see Carver & Harmon-Jones, 2009). Recently, Gable et al. (2015) conducted four studies to assess the effect of anger and therefore motivational intensity on cognitive scope, and collected participant ratings of motivational intensity in only the fourth

study. Here, they compared responses to an angry and a neutral film, and participants rated the angry and neutral film equivalently with respect to their motivational intensity. This challenges the claim that anger is associated with approach motivation. In spite of this Gable et al. (2015) still interpreted their behavioural results as stemming from the differential motivational intensity of these conditions. The differential behavioural results suggest that the conditions do differ in some way. However, we believe it is problematic to attribute this to their motivational intensity in light of the ratings data.

Similarly, Gable et al. (2016, Experiment 5) studied the influence of anger on time perception. Participants in two conditions both watched a film designed to induce anger. Participants in both conditions gave mean ratings indicative of strong avoidance rather than approach motivation (6.82 and 7.05 for the two conditions that both watched the same film, on a scale that ranged from 1 = move toward to 9 = move away). This suggests that the assumption that anger is associated with approach motivation is problematic. To our knowledge, these are the only two studies to have collected ratings of motivational intensity following an anger induction, and neither support the claim that anger is an approach-motivated state. Therefore, this casts doubt on the claim motivational intensity rather than valence is the key determinant of the frontal asymmetry as measured by EEG result, since this conclusion is based on the assumption that anger is associated with approach motivation. Despite this, as recently as 2018, the proponents of the motivational intensity account still offer this as an explanation for the observed frontal asymmetries (see Harmon-Jones & Gable, 2018). This highlights the continued currency of motivational intensity as a construct for explaining observed effects of emotion on brain and behavioural responses, and the urgent need for rigorous approaches to its operationalisation.

Overall, both of these approaches to operationalising motivational intensity make assumptions that have not been subject to systematic testing or validation to confirm that

participants consider the stimuli as having the motivational intensity that the researchers attribute, and when small-scale testing (e.g., responses to a single film) has been conducted, it often contradicts the researchers' claims. Furthermore, the proponents of motivational intensity have not examined the association between motivational intensity and valence and arousal, which we believe is a prerequisite for recommendations about potential proxies.[1]

To summarise, motivational intensity appears to be an important and influential theoretical construct, but what is needed is a stronger basis for operationalising it in experiments on the emotion-cognition nexus, including a greater understanding of how it relates to established dimensions such as valence and arousal. This is what we did in the present study. The following section critically examines in more detail the potential structure of motivational intensity.

3.6 How Should Motivational Intensity be Operationalised?

The definition of motivational intensity (i.e., the urge to move towards/away from a stimulus; (Harmon-Jones, Gable, et al., 2012) suggests that a single dimension is the current accepted structure of motivational intensity, implying it should be measured on a single rating scale. However, this dimensional singularity has never been empirically verified. It is possible that motivational intensity has a dual-structure, whereby approach motivation and avoidance motivation are partially dissociable and should be measured separately. For instance, some stimuli might elicit strong avoidance *and* approach urges: a picture of a person with a deep cut on their leg might elicit a strong urge to avoid because the stimuli is unsettling to look at (Gable & Harmon-Jones, 2010a), but at the same time it may elicit a strong urge to approach to help.

[1] It is worth acknowledging that the Nencki Affective Picture System (NAPS) is the only picture database whereby ratings of motivational direction have been collected for picture stimuli Marchewka, A., Żurawski, Ł., Jednoróg, K., & Grabowska, A. (2014). The Nencki Affective Picture System (NAPS): Introduction to a novel, standardized, wide-range, high-quality, realistic picture database. *Behaviour Research Methods, 46*(2), 596-610. https://doi.org/10.3758/s13428-013-0379-1 . While this is a useful and important first step, their goal was to create a modernised picture database for use in emotional research. This means that the authors did not critically evaluate the conceptualisation, structure, and operationalisation of motivational intensity. Here, our goal was to do this.

Using a single dimension would make it impossible to capture both of these responses. To test whether it is important to measure the urges to approach and avoid separately, Study 1a used two separate scales for these ratings. However, approach and avoidance ratings were very strongly inversely correlated, consistent with motivational intensity existing on a single dimension. Study 1b therefore collected ratings of motivational intensity on a single bidirectional scale, with avoidance at one end and approach at the other.

3.7 The Present Approach

The present work had three primary aims. The first aim was to establish an appropriate method for operationalising motivational intensity, using different types of rating scales. The second aim was to compare motivational intensity with established constructs of emotion, by assessing how ratings of motivational intensity associated with traditional measures of valence and arousal. The third was to assess whether the pivotal relationships observed were also obtained on an implicit measure. A key aspect of this work was to rigorously test the extent to which motivational intensity is distinct from valence and arousal. If motivational intensity is distinct from these established dimensions, then we would expect to see areas of dissociation in their measurement. In Study 1a, we measured approach and avoidance motivation separately, both ranging from low to high. Study 1a also collected ratings of arousal, from calm to aroused, and valence, from unpleasant to pleasant via a neutral mid-point (i.e., a bidirectional scale). In Study 1b, we operationalised motivational intensity on a single bidirectional scale, which ranged from avoid to approach via a neutral mid-point. Ratings of motivational intensity from both studies were then compared with ratings of valence and arousal from Study 1a. Finally, in Study 2, pictures that reflected the full range of motivational intensity ratings from Study 1b were used in a paradigm which used RT in a classification task to provide implicit measures of motivational intensity and valence.

3.8 Study 1a: Separate Measurement of Approach Motivation and Avoidance Motivation

In Study 1a, participants looked at 300 different photographic pictures and rated how much they felt an urge to approach/avoid, or unpleasant/pleasant, or aroused in response. Because Study 1a and all subsequent studies analyses used mean ratings for individual picture stimuli, not individual participants, the appropriate sample for power analysis is the number of pictures, not participants. To achieve power of 0.8 for a medium effect ($r = 0.5$) with $\alpha = .05$ we required N = 29 (calculated with G*Power, Faul et al., 2009; Faul et al., 2007). Thus, our sample size of 300 picture stimuli in Study's 1a and 1b, and 100 picture stimuli in Study 2 exceeded the required power. Note, the large number of pictures was selected to ensure comprehensive representation along all parts of the dimensions under study. Further, evidence suggests that for stable mean ratings, the minimum number of *participants* needed is 20 (DeBruine & Jones, 2018). We had 30 participants performing the ratings on each dimension, and therefore clearly satisfied this criterion. The pictures were 250 pictures from the International Affective Picture System (IAPS) database (Lang et al., 2008) and 50 royalty-free pictures from the Internet similar in nature to those used in previous research on motivational intensity. We had participants rate their motivational intensity on separate approach and avoidance motivation scales so that we could assess whether motivational intensity has a single or dual dimension structure. If the urges to approach and avoidance are related but dissociable, then the correlation between them ought to be modest.

3.8.1 Method

3.8.1.1 Participants. One-hundred-and-twenty participants (79 female, 40 male, 1 other) with ages ranging between 18 and 26 years (Mage= 19.33, SDage= 1.52) who were recruited from the online Australian National University (ANU) SONA recruitment system for one course credit met the inclusion and recruitment criteria for the present study. We used

visual stimuli (i.e., pictures), and therefore one participant recruitment criterion was that participants have normal or corrected-to-normal vision. A large proportion of stimuli may have had specific cultural meaning, and there are also cultural differences in reported emotional experiences, so therefore participant recruitment criteria included that participants were born and raised in a predominately Western identifying countries (e.g., Australia, New Zealand, United States of America, United Kingdom, Canada, or the Republic of Ireland). Since the instructions were in English and required a relatively nuanced understanding of different aspects of emotion described therein, we also required that participants were native English speakers. We also wanted responses to reflect neuro-typical responses, therefore we enforced exclusion criteria for disorders known to affect cognitive and emotional processing. More specifically, participants were recruited on the basis that they reported no major neurological or psychiatric disorders (e.g., ADD/ADHD, Autism Spectrum Disorder, Schizophrenia, or major neurological illnesses requiring hospitalisation). Further, whole cases were removed if they had missing data over 5% (>15) of picture ratings. This and all subsequent studies were conducted in compliance with a protocol (2019/162) approved by the ANU Science and Medical Delegated Ethical Review Committee. Participants provided informed consent prior to commencement of the study. We included questions which screened to check that participants had complied with the above recruitment criteria, and they were excluded from further analysis if they failed to meet any of the above criteria.

***3.8.1.2 Stimuli: Demographic and Debriefing Questionnaires*.** General demographic and background information were gathered from participants in this and all subsequent studies to characterise the sample and to ensure compliance with the recruitment criteria. The demographic and background questions included age, sex, dominant handedness, country of birth, country spent the most time in, first language, normal or corrected-to-normal vision, and the presence of any major neurological or psychiatric disorders. The experiment was conducted

fully-online via Qualtrics, and participants were instructed to resize their screen to 100% viewing size to ensure that the picture and rating scale resolution was appropriate for participants' computer, mobile, or tablet screen.

Participants were also asked to complete debriefing questions at the end of the experiment. The debriefing questions included an indicator of how much effort participants put into the ratings, possible explanations for why they may not have put as much effort as they could have while rating the pictures (e.g., tired or sick), whether they generally eat and enjoy desserts (given that dessert pictures were included, consistent with Gable and Harmon-Jones (2010c); Harmon-Jones and Gable (2009)), and whether they had eaten in the previous two hours. Participants gave responses about how much effort they put into the ratings ranging from 1 (*no effort*) to 10 (*maximum effort*), the average response was 8.02 (*SD* = 1.17, range: 4.00-10.00). In total, 82.5% of participants responded that they generally eat desserts, and 98.3% of participants indicated that they generally enjoy desserts. Moreover, 60% of participants had eaten within 2 hours prior to completing the questionnaire. None of the 120 participants were excluded from final analyses based on their debriefing questionnaire responses because they were not outliers on greater than 5% of picture ratings.

3.8.1.3 Stimuli: Pictures and Rating Scales. Separate rating scales were used to operationalise valence, arousal, approach motivation, and avoidance motivation. Each participant rated all of the pictures on just one of the four dimensions. Each dimension was rated by an equal number of participants (n = 30). Participants only completed one rating scale to avoid response-scale contamination across dimensions. Thirty participants were recruited for each condition, as this exceeds the minimum number needed for stable mean ratings (DeBruine & Jones, 2018). For their allocated dimension, all participants rated 250 IAPS pictures and 50 royalty free pictures from the Internet.

3.8.1.3.1 IAPS Pictures. A total of 250 pictures were selected from the IAPS database (Bradley & Lang, 2007b; Lang et al., 1997, 2008) (see Appendix A for selected IAPS picture numbers). In previous research, each IAPS picture has been rated using the Self-Assessment Manikin (SAM) by approximately 100 participants for feelings of pleasure (i.e., valence, ranging from 1 (*unpleasant*) to 9 (*pleasant*), arousal, ranging from 1 (*calm*) to 9 (*excited*), and dominance, ranging from 1 (*dominated*) to 9 (*in-control*)) (Lang et al., 2008). These ratings have been subsequently validated by a variety of physiological measures that result from viewing the pictures (Bradley et al., 2007; Bradley & Lang, 2007a, 2007b; Codispoti et al., 2007; Cuthbert et al., 2000; Lang et al., 1998).

The IAPS pictures for the present study were chosen to best represent the diverse range of pictures in the IAPS database. To achieve this diversity, five categories were created with different valence and arousal levels. These included 50 pictures from each category that represented: (1) high valence (M = 6.86, range: 6.00-8.02), high arousal (M = 6.56, range: 6.02-7.35); (2) high valence (M = 7.55, range: 7.00-8.34), medium arousal (M = 4.72, range: 4.00-5.83); (3) medium valence (M = 4.93, range: 4.23-5.61), low arousal (M = 2.68, range: 1.72-3.25); (4) low valence (M = 2.12, range: 1.45-2.96), high arousal (M = 6.48, range: 6.00-7.34); and (5) low valence (M = 2.50, range: 1.79-2.98), medium arousal (M = 5.14, range: 4.00-5.98). The reason that these five categories were used is that when pictures are rated high in arousal, they tend to have extreme (pleasant or unpleasant) valence ratings. That is, valence and arousal are not independent, and functionally there are not pictures that have high arousal and neutral valence or low arousal and extreme valence.

***3.8.1.3.2 Royalty Free Pictures*.** A total of 50 royalty free pictures were collected to represent valence and arousal states that were not widely represented in the IAPS database, but that have been used in previous research on motivational intensity. Appendix A lists these pictures. These included pictures of different cuisines (e.g., foods that are regarded ‘desirable’

in Western society, such as fast foods and desserts), and also pictures that represent amusement (e.g., pictures of cats in humorous situations, and pictures that represent amusing scenarios) (Gable & Harmon-Jones, 2008a; for a review, see Harmon-Jones, Gable, et al., 2012). In total, 12 Western cuisine pictures, 13 dessert pictures, 13 pictures of cats in humorous situations, and an additional selection of 12 pictures that were considered to best represented amusement were selected for presentation.

3.8.1.3.3 Valence Ratings. Thirty participants (24 female, 6 male; M_{age} = 18.93, SD_{age} = .98, age range: 18-22) rated how unpleasant (negative) versus pleasant (positive) they felt in response to each picture from -4 (unpleasant) to +4 (pleasant), with 0 being labelled neutral (Figure 3.1a).

3.8.1.3.4 Arousal Ratings. Thirty participants (18 female, 12 male; M_{age} = 19.67, SD_{age} = 2.06, age range: 18-26) rated pictures based on how calm (unaroused) versus aroused (excited) they felt while viewing the picture from 1 (calm) to 9 (aroused), with no neutral point labelled (Figure 3.1b).

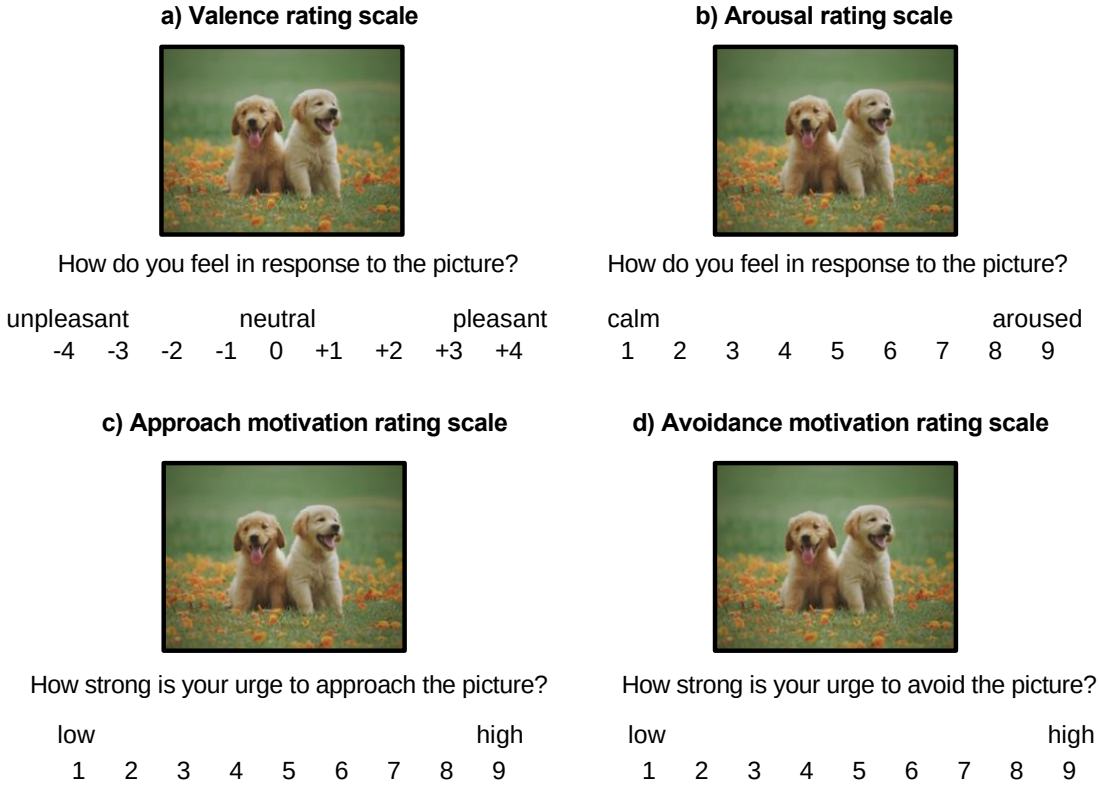
3.8.1.3.5 Approach Motivation Ratings. Thirty participants (19 female, 11 male; M_{age} = 19.7, SD_{age}= 1.74, age range: 18-26) rated pictures based on the strength (low versus high) of their urge to approach (move towards) in response to each picture on a scale from 1 (low) to 9 (high) with no neutral point labelled (Figure 3.1c). This was a new scale created for this study, which was intended to operationalise the approach motivation of various picture stimuli. A 9-point scale was used to be consistent with the valence and arousal scales2.

3.9.1.3.6 Avoidance Motivation Ratings. Thirty participants (18 female, 11 male, 1 other; M_{age} = 19.03, SD_{age} = .89, age range: 18-21) rated pictures based on how strong they felt

[2] In Study 1a, we did not want to make assumptions about the structure of motivational intensity. Therefore, we used a dual-structure of approach motivation and avoidance motivation, so that we could observe the relationship between these two scales. We found a very strong inverse correlation (r_s = -.89) between the approach motivation and avoidance motivation scales, indicating that motivational intensity should be measured on one bi-directional scale (ranging from avoid-approach). This led to the development of the bi-directional scale, which ranged from -4 (*avoid*) to +4 (*approach*) in Study 1b.

their urge to avoid (move away from) in response to each picture on a scale from 1 (*low*) to 9 (*high*) with no neutral point labelled (Figure 3.1d). For the same aforementioned reasons, this was a new scale produced for this study to operationalise the avoidance motivation of the picture stimuli.

Figure 3.1 *Example of Stimulus and Rating Scales Used in Study 1a*



Note. (a) Valence rating scale with a neutral point (0) included. (b) Arousal rating scale (neutral point not included). (c) Approach motivation rating scale (neutral point not included). (d) Avoidance motivation rating scale (neutral point not included). The example stimulus shown here is not an actual IAPS picture due to constraints around publications as not to compromise its success as a research tool, but this picture embodies a type of picture used in the IAPS.

3.8.1.4 Design and Procedure. The study took approximately 1 hour to complete, and participants were compensated with course credit for their time. Prior to participation, in addition to general information about the experiment, participants were given explicit warning about the nature of the emotionally-evocative pictures (e.g., erotica, mutilated bodies, attacks, violence, and frightening animals) that were to be presented. They were told that they were

able to withdraw from participation at any time if they felt uncomfortable. Participants then provided voluntary informed consent via a response to an explicit question about consent. If they answered no to this question, they did not continue beyond this point and were not included in the study.

Next, participants completed the background and demographics questionnaire detailed above. Participants were allocated to one of the four dimensions (valence, arousal, approach motivation, and avoidance motivation) based on which version of the study they selected on the research participation recruitment site (i.e., SONA). Note that the different versions made no reference to the dimension they would be rating, and instead were all simply equivalent variants of a generic picture rating study (e.g., "Online Image Rating Study" versus "Online Photo Rating Study"). Participants were unaware of the condition that they were allocated to because this was not outlined on the recruitment platform.

Participants were given clear instruction that they would be rating pictures based on 'how each picture made them feel at the time of viewing'. Onscreen instructions were provided on how to use the rating scale for each dimension. For the valence dimension, extra instructions were given to provide explanation on how to use the neutral point on the scale (see Appendix B for the specific instructions of each dimension and the definitions of each construct).

Participants first completed 12 practice viewing and ratings of pictures from the Internet that represented the six different categories used. Although there are no correct or incorrect answer for ratings, this helped to familiarise them with the task and the rating scale. After completion of the practice block, participants were informed that the next stage was the main block. The main block consisted of 300 pictures and rating scales, each presented together on the screen until response. If participants did not respond before continuing, a response was requested, but not required, before continuing. The order of the picture and rating scale presentation was randomised for each participant. After completion of the experimental block,

participants were presented with the debrief questions. Finally, participants were presented with 20 mildly positive royalty free pictures from the Internet. This was designed to mitigate any negative emotional impact resulting from the emotionally-evocative pictures.

3.8.1.5 Data Screening. Overall, there was 0.04% missing individual scores across all remaining 120 participants, which were omitted from the average for each of their relative pictures. Participants' individual scores across all pictures were assessed for outliers. The criterion for determining and removing outliers was individual participants' ratings for a given picture where the z-scores values exceeded the absolute value of 3.29 relative to how all of the other participants rated that particular picture. This was assessed for all 300 pictures across all participants' scores (Tabachnick & Fidell, 2013). A total of two whole cases (i.e., all of an individual's data) were removed for being outliers on more than 15 (5%) pictures. An average of 0.24% individual outlier scores were removed across all remaining 120 participants. The four dimensions were assessed for normality. For some variables the distributions were not normal, suffering from significant skew or kurtosis (skew or kurtosis z-scores > 3.29), therefore, non-parametric Spearman's correlational analyses was used. Note that the results were similar when parametric correlations were used, see Supplementary Information.

3.8.2 Results and Discussion

Means and standard deviations for each picture on each dimension in this study, as well as a description and number of each picture is presented in the Supplementary Information, Table S1. Data can be found at the following Open Science Framework link: https://osf.io/zfnvj/?view_only 971b9c152a2d4eb5999ccd674509e817. Please see Table S3 in the Supplementary Information for the Pearson's *r* correlations for each of the analyses discussed below.

3.8.2.1 Reliability. Each of the rating scales had high levels of internal consistency, as indicated by Cronbach's α. The valence, arousal, approach motivation, and avoidance

motivation ratings scales all had excellent internal consistency (Cronbach's α = .99, .96, .96, .98). Moreover, the maximum correlation that can be observed between two variables is constrained by the measurement reliability of both variables. This is quantified in Spearman's attenuation-correction formula (i.e., $r_{\text{true}} = \frac{r_{\text{observed}}}{\sqrt{r_{xx} \times r_{yy}}}$) (Parsons et al., 2019; Spearman, 1904). Therefore, we reported the r_{true} for each of the primary analyses in this and all subsequent studies.

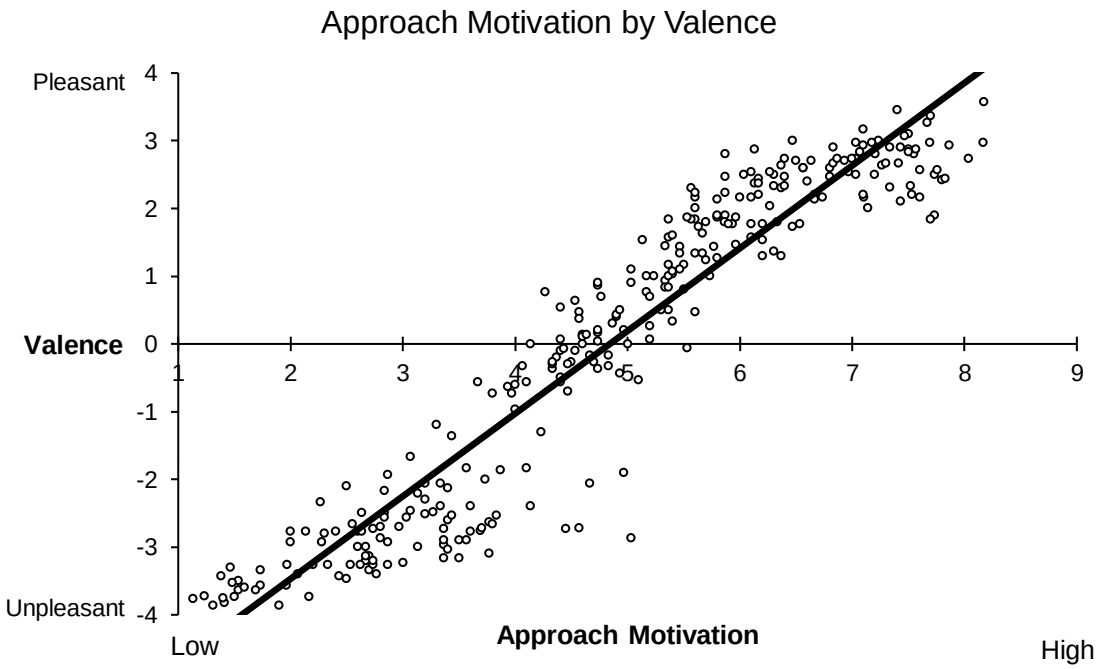
3.8.2.2 Validation Check. For the 250 IAPS pictures, the relationship between the original ratings of valence and arousal collected using the SAM (Lang et al., 2008) and the ratings of these constructs from the present study was assessed via correlational analyses. The logic here was that if our methodology was functioning as expected, we should see strong associations between how our participants and the participants in the original IAPS study rated these pictures on valence and arousal. As expected, we observed strong and significant positive correlations between SAM valence ratings and our valence ratings, $r_s(248) = .95$, $p < .001$, [95% CI = .94 to .96] and between SAM arousal ratings and our arousal ratings, $r_s(248) = .82$, $p < .001$ [95% CI = .78 to .86]. This was despite us using a different rating scale, different participants, and collecting data several decades after original SAM ratings were collected.

3.8.2.3 The Structure of Motivational Intensity. The structure of motivational intensity was examined by assessing the association of the scores from the present study approach motivation and avoidance motivation. A Spearman's r_s correlation indicated that there was a very strong negative correlation between approach motivation scores and avoidance motivation scores, $r_s(298) = -.89$, $p < .001$ [95% CI = -.91 to -.86]. This strong inverse correlation means that pictures that received high approach ratings received correspondingly low avoidance ratings. While it cannot be ruled out for all pictures, there is clear evidence against the notion that approach motivation and avoidance motivation are systematically independent dimensions. Instead, it supports the notion of a single dimension of motivational intensity.

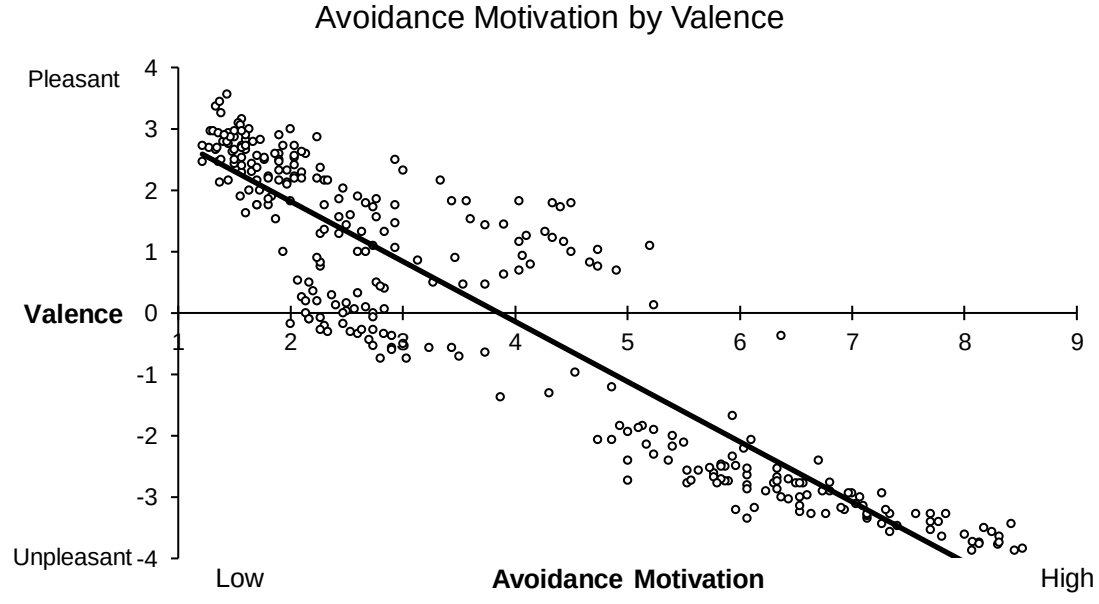
3.8.2.4 Motivational Intensity and Valence. To explore the relationship between motivational intensity and valence, the correlation between both approach motivation and avoidance motivation on the one hand and valence on the other were considered. Approach motivation scores and valence scores were very strongly correlated, $r_s(298) = .96$, $p < .001$, [95% CI = .95 to .97], indicating an extremely high degree of correspondence between these two constructs (Figure 3.2a). That is, the pictures that were rated high on approach motivation were overwhelmingly likely to also be rated by other participants as high on valence. The estimated r_{true} for approach motivation and valence is $r_{\text{true}} = \frac{.96}{\sqrt{.96 \times .99}} = .98$, which supports the high degree of correspondence between these two constructs. Moreover, avoidance motivation and valence were negatively correlated, $r_s(298) = -.91$, $p < .001$, [95% CI = -.93 to -.89] indicating that avoidance motivation and negative valence also share a very high degree of overlap (Figure 3.2b). The estimated r_{true} of avoidance motivation and valence is $r_{\text{true}} = \frac{-.91}{\sqrt{.98 \times .99}} = -.92$, which supports the high degree of correspondence between these two constructs.

Figure 3.2 *Scatterplots of (a) Approach Motivation by Valence and (b) Avoidance Motivation by Valence*

a)



b)

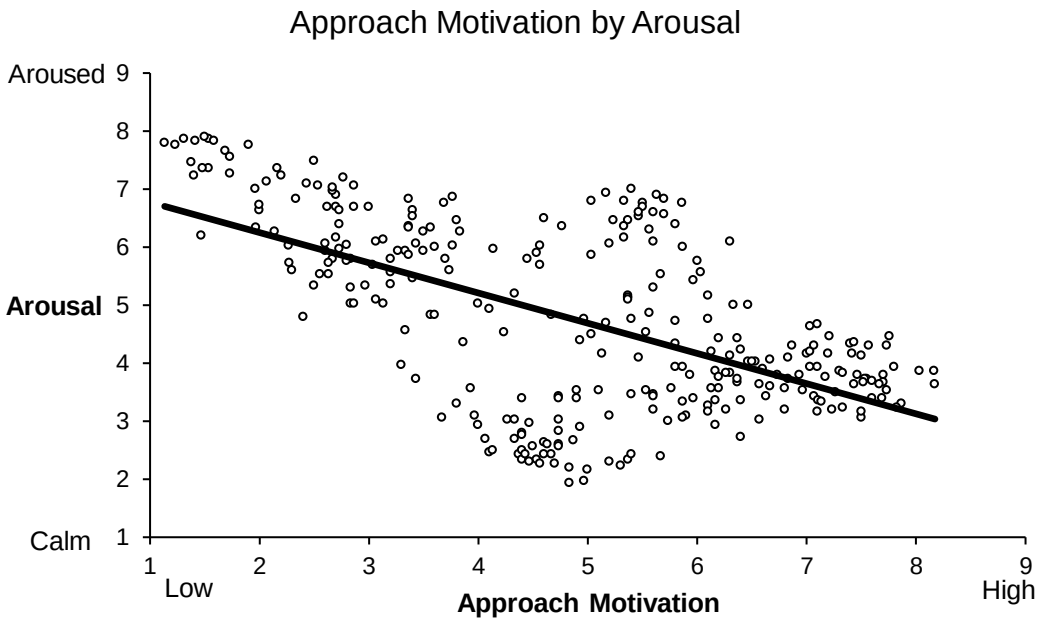


Note. Scatterplots of (a) approach motivation by valence (r_s = .96) and (b) avoidance motivation by valence (r_s = -.91). Each dot represents the mean rating for a given picture on that rating scale. Black line indicates line of best fit. Approach motivation range: 1 (*low*) to 9 (*high*). Avoidance motivation range: 1 (*low*) to 9 (*high*). Valence range: -4 (*unpleasant*); +4 (*pleasant*); 0 (*neutral*).

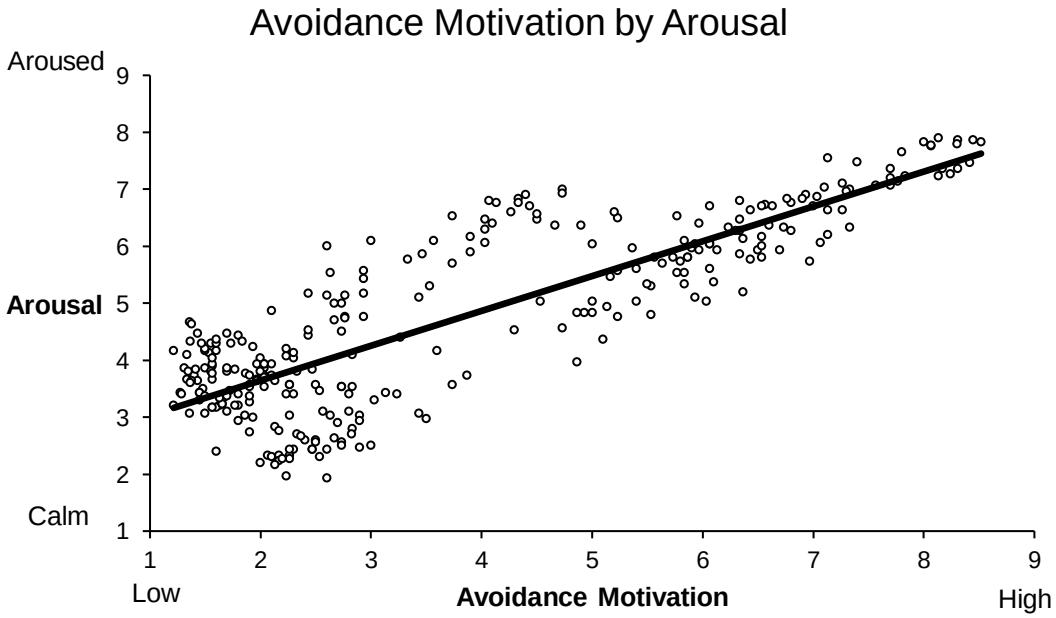
3.8.2.5 Motivational Intensity and Arousal. To examine the relationship between motivational intensity and arousal, the scores of both approach motivation and avoidance motivation were correlated separately with arousal. Approach motivation scores and arousal scores were moderately inversely correlated, $r_s(298) = -.52$, $p < .001$ [95% CI = -.60 to -.43]. The r_{true} for approach motivation and arousal is $r_{\text{true}} = \frac{-.52}{\sqrt{.96 \times .96}} = -.54$. This indicates a degree of a relationship, albeit in the opposite direction to that predicted by the recommendation that increasing arousal serves as a proxy for increasing motivational intensity (Figure 3.3a). Moreover, avoidance motivation scores and arousal scores were positively correlated, $r_s(298) = .76$, $p < .001$, [95% CI = .71 to .80], and the $r_{\text{true}} = \frac{.76}{\sqrt{.98 \times .96}} = .79$, suggesting that avoidance motivation and arousal are related, yet distinct. That is, while they share variance, there is also substantive unshared variance as well (Figure 3.3b).

Figure 3.3 *Scatterplots of (a) Approach Motivation by Arousal and (b) Avoidance Motivation by Arousal*

a)



b)

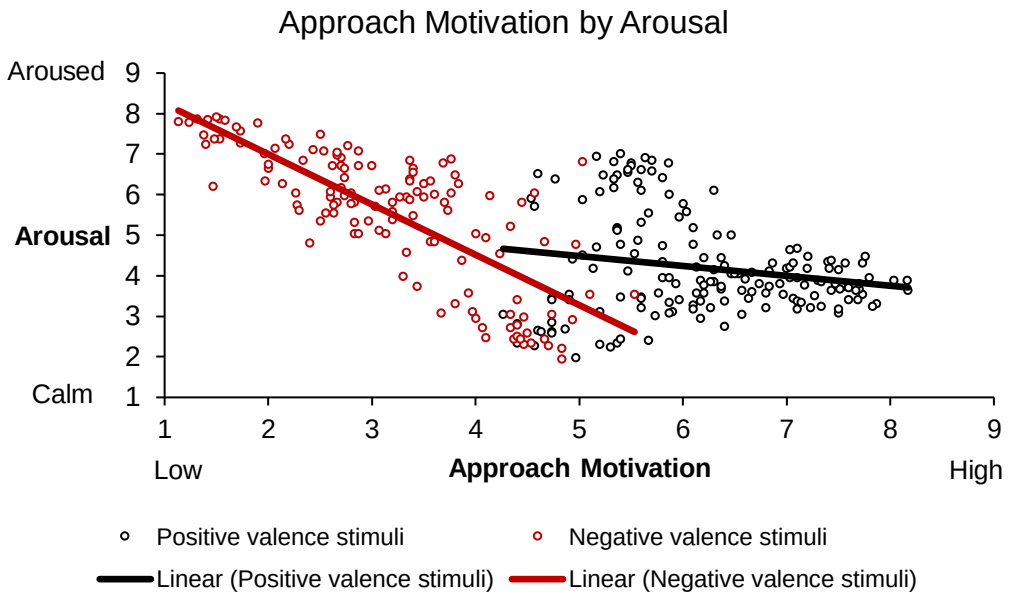


Note. Scatterplots of (a) approach motivation by arousal (r_s = -.52) and (b) avoidance motivation by arousal (r_s = .76). Each dot represents the mean rating (averaged across participants) for a particular picture on that scale. Line indicates line of best fit. Approach motivation 1 (*low*); 9 (*high*). Avoidance motivation range: 1 (*low*); 9 (*high*). Arousal range: 1 (*calm*); 9 (*aroused*).

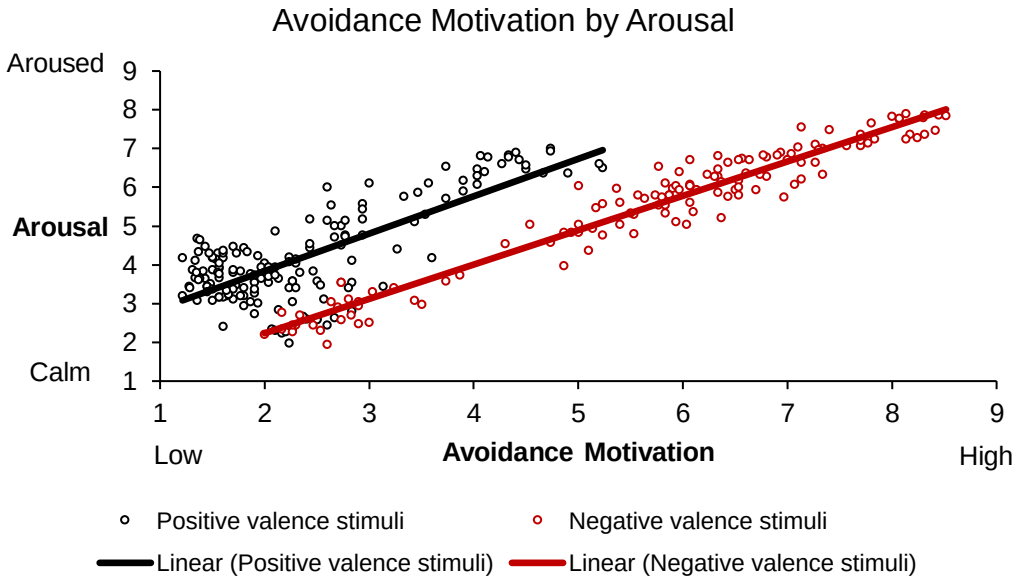
The previous analyses showed a high degree of correspondence between motivational intensity and valence, indicating substantial overlap between the two constructs. Moreover, an issue with the dual-structure of approach motivation and avoidance motivation is that both of these scales captured the full range of picture stimuli. It is possible that the approach motivation and avoidance motivation rating scales were treated by participants as bi-directional approach-avoidance scales rather than ranging from low to high on approach motivation and avoidance motivation. Therefore, it is important to examine positive (> 0) and negative (< 0) valence stimuli separately across the approach motivation and avoidance motivation rating scales. There was no reliable relationship for approach motivation and arousal for positive valence stimuli, $r_s(165) = -.11$, $p = .179$, [95% CI = -.26 to .04]. Moreover, approach motivation and arousal were inversely correlated for negative valence stimuli, $r_s(128) = -.79$, $p < .001$, [95% CI = -.85 to -.72]. This indicates there is a relationship for only negative valence stimuli between approach motivation and arousal (Figure 3.4a). There was a moderate correlation between avoidance motivation and arousal for positive valence stimuli, $r_s(165) = .50$, $p < .001$, [95% CI = .38 to .61], and a very strong correlation between avoidance motivation and arousal for negative valence stimuli, $r_s(128) = .95$, $p < .001$, [95% CI = .93 to .96] (Figure 3.4b), suggesting that avoidance motivation and arousal are related. Overall, there was an inconsistent relationship between motivational intensity and arousal, which indicates that arousal may not be an appropriate proxy for motivational intensity.

Figure 3.4 *(a) Approach Motivation by Arousal and (b) Avoidance Motivation by Arousal Plotted Separately for Positive Valence and Negative Valence Stimuli*

a)



b)



Note. (a) Approach motivation and arousal plotted separately for positive valence stimuli (r_s = -.11) and negative valence stimuli (r_s = -.79). (b) Avoidance motivation and arousal plotted separately for positive valence stimuli (r_s = .50) and negative valence stimuli (r_s = .95). Each dot represents the mean rating (averaged participant response) for each picture on that rating scale. Black line indicates line of best fit for positive valence stimuli. Red line indicates line of best fit for negative valence stimuli. Approach motivation range: 1 (*low*); 9 (*high*). Avoidance motivation range: 1 (*low*); 9 (*high*). Arousal range: 1 (*calm*); 9 (*aroused*).

3.8.2.6 Summary. Here, motivational intensity and valence showed a very strong relationship with one another. In fact, the relationships were so high, that one might even question whether motivational intensity is in fact a distinct construct from valence. In contrast, the relationships between motivational intensity and arousal were weaker and less consistent. However, in Study 1a we used two separate rating scales for the approach and avoidance aspects of motivational intensity, which meant that both of these separate rating scales captured the full range of picture stimuli. Given that approach motivation and avoidance motivation were very highly negatively correlated, this suggests that it may be more appropriate to measure motivational intensity on a single rating scale. This is what we did in Study 1b. This would allow us to assess whether the same relationships between approach motivation and avoidance motivation and arousal held when motivational intensity was rated on a single rating scale.

3.9 Study 1b: Combined Measurement of Approach Motivation and Avoidance Motivation on a Singular Dimension

In Study 1b, we sought to assess the robustness of results of the previous study by operationalising motivational intensity as a single dimension. Specifically, we replaced the separate approach and avoidance scales with a bidirectional scale that measured motivational intensity from avoid to approach via a neutral mid-point, and these responses were compared with the valence and arousal ratings from Study 1a.

3.9.1 Method

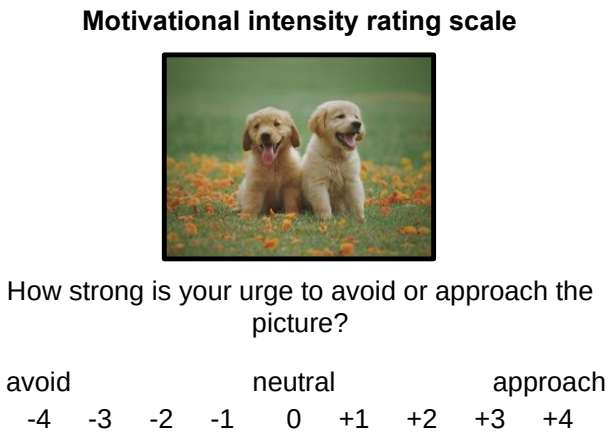
3.9.1.1 Participants. Participants were 30 undergraduate students aged 18 to 23 years (M_{age} = 20.1, SD_{age} = 1.4; 22 female, 8 male) recruited from the ANU community via an online system for course credit[3]. Recruitment and exclusion criteria were as for Study 1a. In Study 1b,

[3] The difference in sample sizes across Study 1a and 1b was due to the between-subjects design used in the current study. In total, there were 120 participants in Study 1a because each of the four dimensions employed 30 participants (30 x 4 = 120). Study 1b had a sample size of 30 because there was only one dimension being tested. Thus, Study 1a and 1b were consistent in that 30 participants were used per dimension.

participants rated how much effort they put into their responses, ranging from 1 (*no effort*) to 10 (*maximum effort*), the average response was 8.37 (*SD* = 1.16, range: 6.00-10.00). 70% of participants responded that they generally eat desserts, 93.3% of participants indicated that they generally enjoy desserts, and 70% of participants had eaten within 2 hours prior to completing the questionnaire. Please see Table S4 and S5 in the Supplementary Information for analyses on how ratings changed as a product of eating-behaviour.

3.9.1.2 Stimuli and Procedure. The stimuli and procedure were identical to those used in Study 1a. This time however, participants rated how much they felt an urge to avoid (move away from) or approach (move towards) in response to each picture, on a scale from -4 (avoid) to +4 (approach), with 0 labelled as the neutral point (Figure 3.5).

Figure 3.5 *Example of the Stimulus and Rating Scale Used in Study 1b*



Note. Motivational intensity rating scale with a *neutral* point (0) included. 9-point rating scale ranging from -4 (*avoid*) to +4 (*approach*). The example stimulus shown here is not an actual IAPS picture due to constraints around publications as not to compromise its success as a research tool, but this picture embodies a type of picture used in the IAPS.

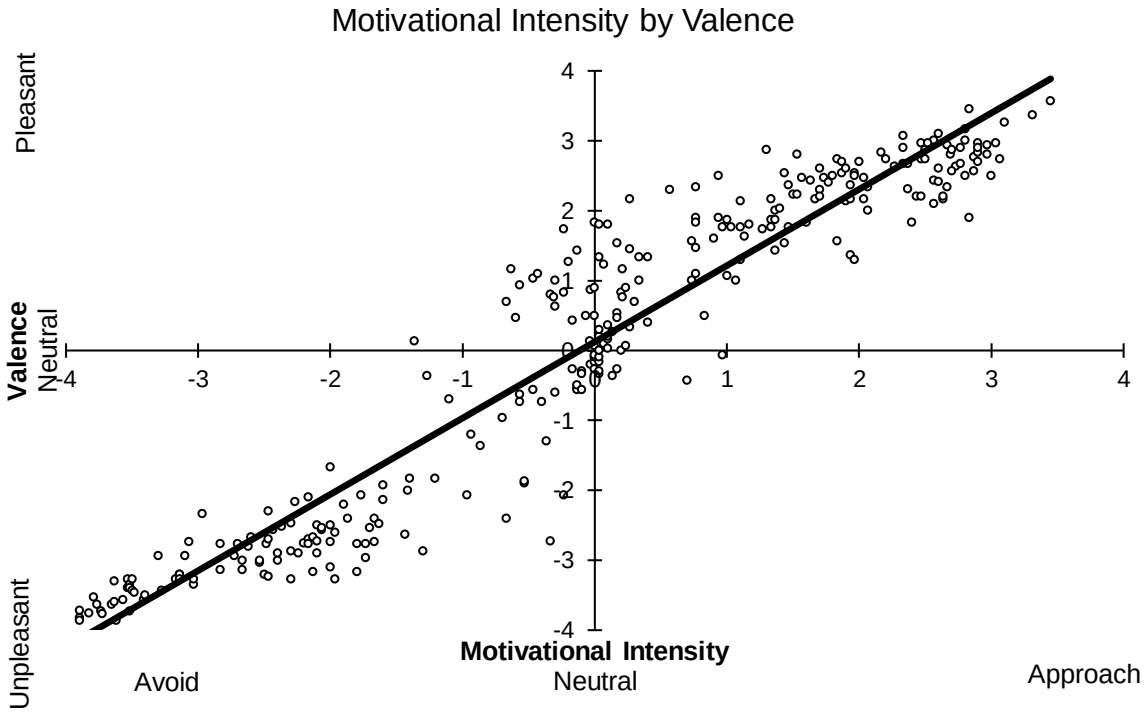
3.9.2 Results and Discussion

Means and standard deviations of the ratings for each picture on each dimension as well as a short description of the picture is presented in the Supplementary Information, Table S1. Participants' scores were assessed for outliers across all pictures. The criterion for determining and removing outliers was ratings where there z-scores values exceeded the absolute value of

z = 3.29 on any of the 300 pictures (Tabachnick & Fidell, 2013). One whole case was excluded from final analyses for being an outlier on more than 5% of pictures. An average of 0.41% individual outlier scores were removed across all 30 participants. There was an average of 0.05% missing individual scores across all remaining 30 participants, which were omitted from the averages of their respective pictures. The distributions were not normal for all variables, therefore Spearman's rho was used. Please see Table S3 in the Supplementary Information for the Pearson's r correlations for each of the analyses discussed below. Further, the new motivational intensity rating scale had excellent internal consistency (Cronbach's $\alpha = .97$).

The ratings on this new dimension were compared with the valence and arousal ratings of the same pictures from Study 1a. There was a very strong correlation between motivational intensity and valence scores, $r_s(298) = .96$, $p < .001$, [95% CI = .95 to .97], with the $r_{\text{true}} = \frac{.96}{\sqrt{.97 \times .99}} = .98$, indicating an exceptionally high degree of overlap between these two dimensions (see Figure 3.6). This supports findings from Study 1a that motivational intensity and valence are very closely related, such that it challenges the notion that motivational intensity exists independent of valence.

Figure 3.6 *Scatterplot of Motivational Intensity (Study 1b) by Valence (Study 1a)*

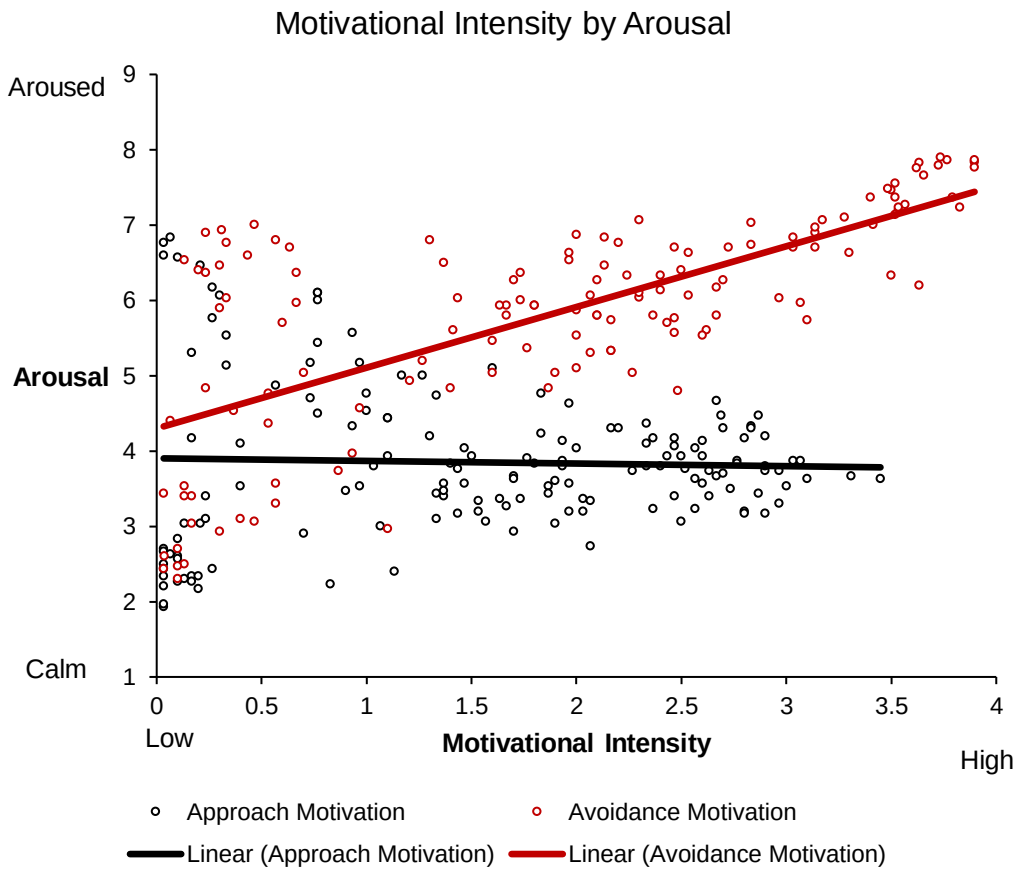


Note. Scatterplot of motivational intensity (Study 1b) by valence (Study 1a) (r_s = .96). Each dot reflects the mean rating of a particular picture. Line indicates line of best fit. Motivational intensity range: -4 (*avoid*) to +4 (*approach*), with 0 as *neutral*; Valence range: -4 (*unpleasant*) to +4 (*pleasant*), with 0 as neutral.

The relationship between the single dimension of motivational intensity and arousal was also examined. The single dimension motivational intensity absolute scores (i.e., considering the magnitude of the scores ignoring their sign) were assessed against arousal scores to answer the question regarding whether arousal is an appropriate proxy for motivational intensity. Considering absolute value is necessary because unlike valence which is essentially bipolar (negative to positive), arousal is conceptualised and measured on a single dimension from low to high arousal. Therefore, taking the absolute value of the motivational intensity score renders it on a comparable scale to arousal. Eight pictures were excluded from the following analyses because they received true motivational intensity ratings of 0 averaged across all participants. Here, a moderate correlation was observed between motivational intensity and arousal scores, $r_s(290) = .41$, $p < .001$, [95% CI = .31 to .50], with the $r_{\text{true}} =$

$\frac{.41}{\sqrt{.97 \times .96}}$ = .42, indicating that there is a moderate relationship between motivational intensity and arousal when the absolute scores of avoidance motivation and approach motivation are considered together (see Figure 3.7). To explore this question further, the data was split by approach motivation and avoidance motivation so that the relationship between both of these motivational directions could be assessed with arousal separately. There was a significant correlation between the ratings of the pictures for avoidance motivation and arousal, $r_s(135)$ = .69, $p < .001$, [95% CI = .59 to .77], with the $r_{\text{true}} = \frac{.69}{\sqrt{.97 \times .96}}$ = .72, indicating that avoidance motivation and arousal are related. However, there was no reliable correlation observed between approach motivation and arousal rating scores, $r_s(153)$ = .10, p = .204, [95% CI = -.06 to .25], with the $r_{\text{true}} = \frac{.10}{\sqrt{.97 \times .96}}$ = .10, indicating that there is not a meaningful relationship between approach motivation and arousal. Although a relatively strong relationship was observed between avoidance motivation and arousal, overall, arousal is not an appropriate proxy for motivational intensity because there was no relationship observed between approach motivation and arousal.

Figure 3.7 *Scatterplot of Motivational Intensity (Study 1b) against Arousal (Study 1a), Separated by Approach Motivation and Avoidance Motivation*



Note. Scatterplot of motivational intensity (Study 1b) against arousal (Study 1a) (r_s = .41), separated by approach motivation (r_s = .10) and avoidance motivation (r_s = .69). The absolute score of approach motivation and avoidance motivation has been used in this analysis. Each dot represents the mean rating score for a given picture. Black line indicates line of best fit for approach motivation, red line indicates line of best fit for avoidance motivation. Motivational intensity range: 0 (*low*); 4 (*high*). Arousal range: 1 (*calm*); 9 (*aroused*).

3.9.3 Summary

The results from Study 1b replicated the findings from 1a, where we found an overwhelming correspondence between motivational intensity and valence. This supports the notion that motivational intensity is not a distinct construct, and instead appears to be another label for the existing and well-established dimension of valence. However, Studies 1a and 1b relied on self-report measures. We do not think this is intrinsically problematic, as the validity of a measure (i.e., does it selectively and sensitively gauge the construct of interest?) is more

important than whether it is explicit or implicit. Indeed, emotions include subjectively experienced aspects, which we expect participants are able to report with a reasonable degree of accuracy. However, in Study 2, we sought converging evidence for our conclusion on an implicit measure.

Our design was derived from one key piece of information: reaction times (RTs) gauge decisional uncertainty (e.g., Kiani et al., 2014). When participants make a classification judgement RTs are slower when this decision is ambiguous or otherwise difficult than when it is clear-cut and easy. This means that if participants are classifying the valence of their emotional response, they should be faster to make this decision for pictures that elicit more extreme positive or negative reactions, and slower for neutral pictures. The same logic applies for motivational intensity, for pictures that are easy to classify (i.e., strong urge to approach or avoid), RTs will be faster, and for pictures that are less easy to classify (i.e., pictures classified as neutral) RTs will be slower. Therefore, RT is used as an implicit measure to classify the valence and motivational intensity of the picture-evoked emotion.

Crucially, if motivational intensity and valence are overwhelming related and different labels for the construct as we have argued, there should be a high correlation between the valence and the motivational intensity-based RTs to each picture. The same pictures that produce quick RTs when participants are classifying the pictures according to valence should also facilitate quick RTs when participants are classifying the pictures according to the motivational intensity. Similarly, the same pictures that produce slow RTs on valence should produce slow RTs on motivational intensity.

3.10 Study 2: Behavioural Measure of Motivational Intensity and Valence

3.10.1 Method

3.10.1.1 Participants. Thirty participants (26 female) aged between 19 and 38 (M_{age} = 25, SD_{age} = 3.45) were recruited by word of mouth or through ANU's online recruitment

platform (SONA) and either volunteered their time or were offered compensation in 1 course credit for eligible courses (when participation was completed in conjunction with course-specific requirements). One participant was excluded and replaced due to not being born in a Western country. All participants included in final analyses met the recruitment criteria as detailed in Study 1a and 1b.

3.10.1.2 Stimuli. The study was conducted online via Testable (www.testable.org). In ascending order, every 3rd ranked picture (100 pictures total) were selected from the motivational intensity ratings collected in Study 1b (see Appendix C for a list of the pictures used). This was done to ensure that a diverse range of pictures that represented the motivational intensity scale were selected.

Black borders were removed from IAPS pictures, and each landscape and portrait picture were resized to 600px wide and 600px high, respectively. For each trial, pictures were presented in the centre of participants screens. Pictures were presented on a white background.

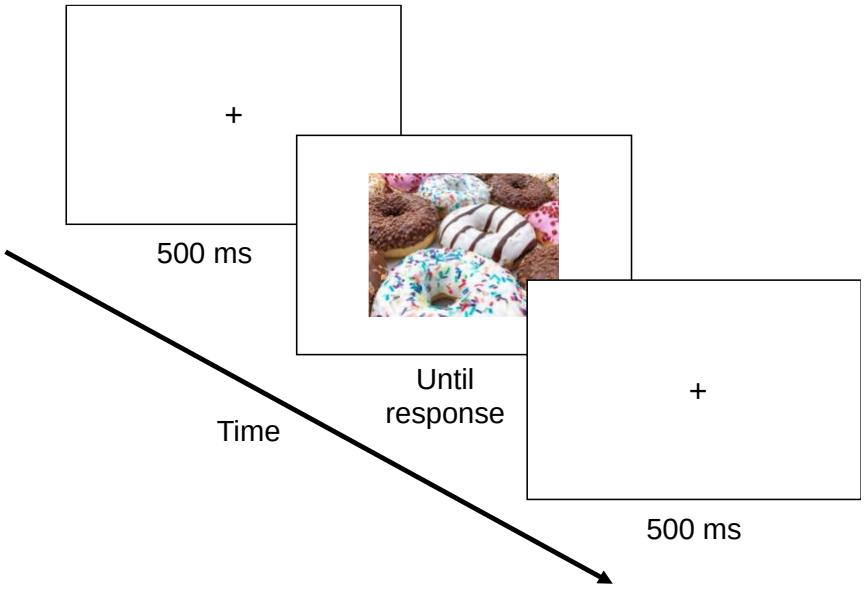
3.10.1.3 Procedure. A within-subjects design was employed for this study, with the dependent variable RT. The study took approximately 45 minutes to complete. There were two blocks involved in this experiment (Motivational Intensity and Valence). Once participants had completed the two blocks the first time (Motivational Intensity$_{block\text{-}1}$ and Valence$_{block\text{-}1}$), they then repeated the two blocks again (Motivational Intensity$_{block\text{-}2}$ and Valence$_{block\text{-}2}$). The repetition of the blocks was included to examine the internal consistency and reliability of the Motivational Intensity and Valence measures. Order presentation of the blocks was counterbalanced among participants, however, it was ensured that Motivational Intensity$_{block\text{-}1}$ and Valence$_{block\text{-}1}$ came before Motivational Intensity$_{block\text{-}2}$ and Valence$_{block\text{-}2}$.

In Motivational Intensity$_{block\text{-}1}$ and Valence$_{block\text{-}1}$ participants completed 10 practice trials (prior to the experimental trials) on pictures that were not included in the experimental blocks. Within each of the experimental blocks (Motivational Intensity or Valence) participants

made responses to the same 100 picture stimuli from Study 1b. Order presentation of the pictures were randomised in each block. Following completion of the experimental blocks, all participants viewed but did not make responses to 20 pictures sourced from the Internet for 3 s, which was designed to mitigate the effect of the negative images on participants.

On each trial, for both of the Motivational Intensity and Valence blocks, after a period of fixation (500 ms), the picture stimulus was shown until participants made a response. In the valence blocks, participants' task was to classify their emotional response to the picture using the arrow keys on their keyboard (left key for unpleasant; right key for pleasant). For the motivational intensity blocks, participants were instructed to classify if they felt an urge to avoid the picture using the arrow keys on their keyboard (left key for avoid; right key for approach). Participants were instructed to respond as quickly and accurately as possible. After participants made their response, another central fixation cross appeared (500 ms), which represented the inter-trial interval (see Figure 3.8 for an example of a single trial in Study 2).

Figure 3.8 *Schematic Illustration of a Single Trial Used in Study 2*



Note. One-hundred picture stimuli were selected from Study 1b ratings. Picture presentation was randomized within each block. Response was either avoid or approach (Motivational Intensity blocks), or unpleasant or pleasant (Valence blocks). Order of block presentation is counterbalanced among participants.

3.10.2 Results and Discussion

In the following sections, we first calculated the reliability of measures to provide an estimate of the expected upper bound (r_{true}) of possible observed relationships motivational intensity and valence. Given that RT measures typically have imperfect reliability, we calculated a r_{true} value when assessing the relationship between valence and motivational intensity.

We then assessed the evidence for our assumption that RTs would change as a function of the extremeness of the motivational intensity rating that the picture received in Study 1b. Finally, we calculated the correlation between our implicit measures of valence and motivational intensity to assess the key research question.

Table 3.1 reports the means, SDs and Cronbach's α for each measure, by block and combined. The first and second blocks within each task were strongly correlated (motivational intensity: $r(98) = .72$, $p < .001$, [95% CI = .61 to .80]; valence: $r_s(98) = .71$, $p < .001$, [95% CI

= .60 to .80][4]) and combining the two blocks increased internal consistency relative to each of the individual blocks. Thus, we collapsed across the two blocks within each task in all subsequent analysis. Please see Appendix D in the Supplementary Information for test-retest reliability.

Figure 3.9 illustrates the relationship between ratings of motivational intensity from Study 1b and mean reaction times in the motivational intensity decision and valence decision tasks in Study 2 (Supplementary Table S2 also presents data for each stimulus). As expected, reaction times were slower for pictures around the midpoint of the motivational intensity rating scale, and faster for pictures at the extreme ends of the scale, forming a V-shaped relationship. Given that the linear relationships were expected to go in different directions as a function of whether motivational intensity ratings were above or below zero (i.e., positive for avoid pictures and negative for approach pictures, forming the V-shape), we calculated correlations with motivational intensity and valence RTs separately for the pictures with motivational intensity ratings below and above zero. Three pictures were excluded from analyses because they received true 0 motivational intensity ratings averaged across all participants. Four correlations were calculated (shown in Figure 3.9) that support the V-shape pattern.

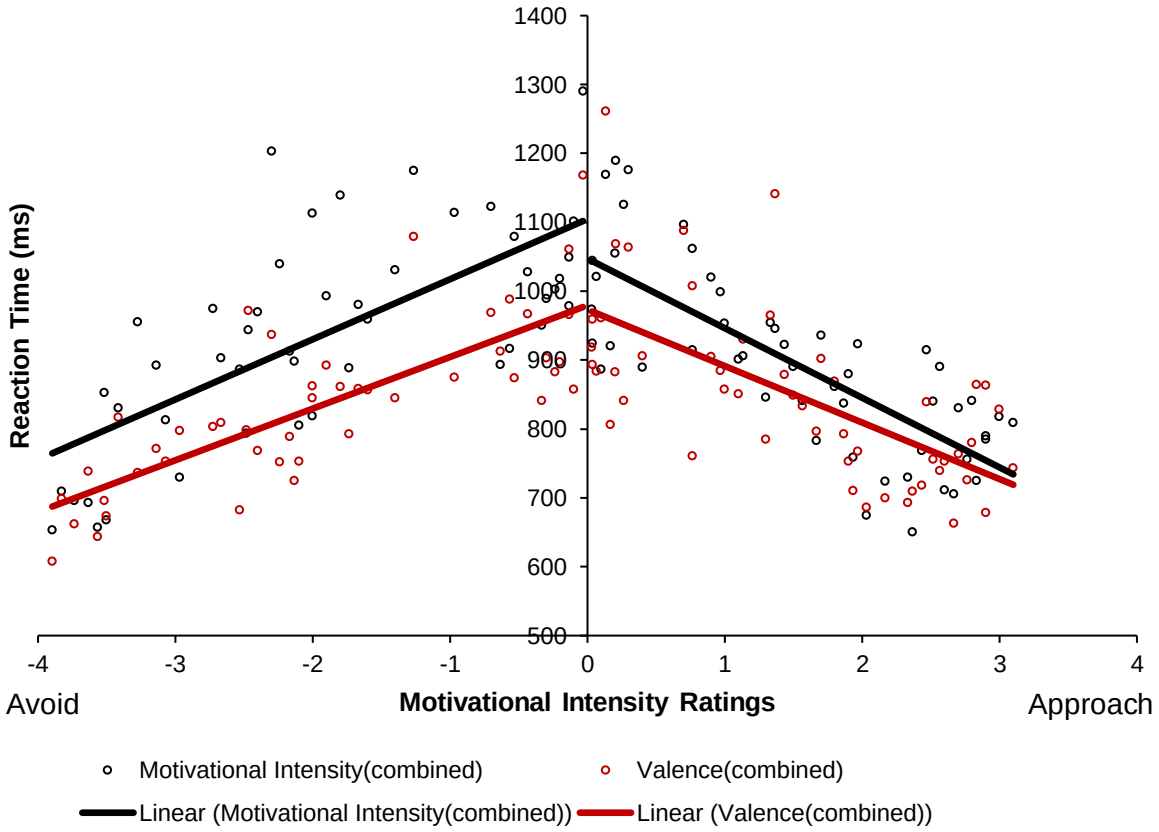
[4]Here, we reported non-parametric Spearman's *r* because $Valence_1$ and $Valence_2$ were non-normal (i.e., skew and kurtosis scores >1.96). The Pearson's *r* for $Valence_1$ and $Valence_2$ was, $r(98) = .62$, $p < .001$. All other RT variables were normally distributed.

Table 3.1 *Descriptive Statistics for Reaction Time (RT) Variables in Study 2 (N = 100)*

RT Variable	*Mean* (ms)	*SD* (ms)	Cronbach's α
Motivational Intensity$_1$	1051	202	.69
Motivational Intensity$_2$	786.4	105	.57
Motivational Intensity$_{combined}$	919	143	.79
Valence$_1$	934	170	.79
Valence$_2$	759	103	.53
Valence$_{combined}$	847	123	.80

Note. Motivational Intensity$_{combined}$ is each motivational intensity picture rating averaged across Motivational Intensity$_{block\text{-}1}$ and Motivational Intensity$_{block\text{-}2}$. Valence$_{combined}$ is each valence picture rating averaged across Valence$_{block\text{-}1}$ and Valence$_{block\text{-}2}$. Sample size refers to number of pictures used in the analyses.

Figure 3.9 *Motivational Intensity Ratings Against Motivational Intensity*$_{combined}$ *and Valence*$_{combined}$

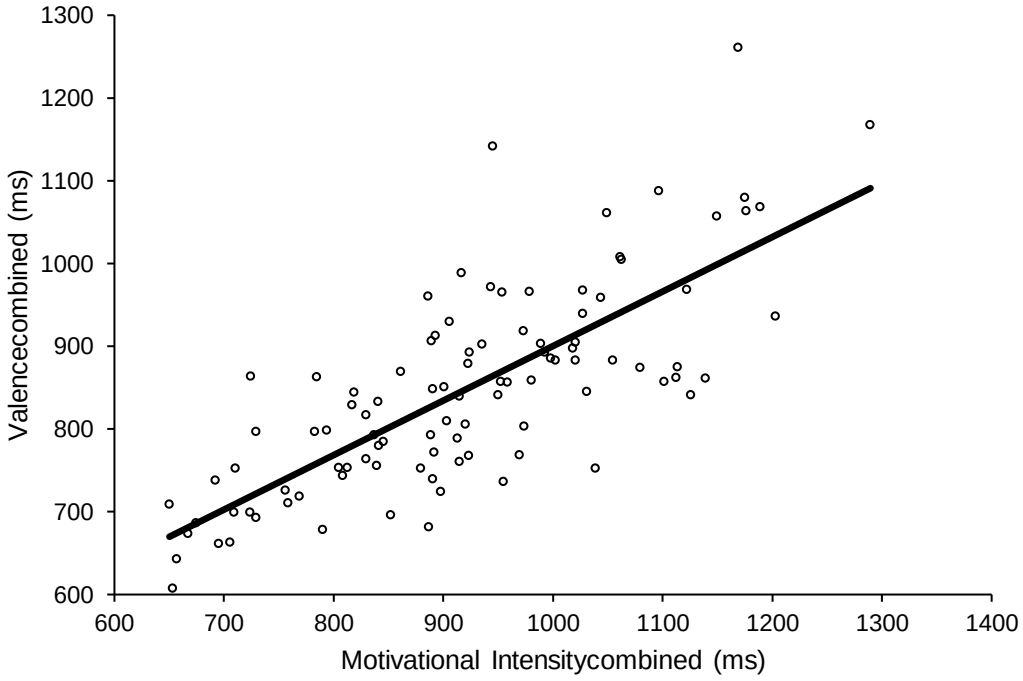


Note. Scatterplot of avoidance motivation ratings (Study 1b) against Motivational Intensity$_{combined}$ (r(44) =.70, p <.001, [95% CI = 0.51 to 0.82], Study 2) and Valence$_{combined}$ (r(44) =.78, p <.001, [95% CI = 0.633 to 0.873], Study 2), and approach motivation ratings (Study 1b) against Motivational Intensity$_{combined}$ (r(49) = -.77, p <.001, [95% CI = -0.863 to -0.628], Study 2) and Valence$_{combined}$ (r(49) = -.65, p <.001, 95% CI = -0.785 to -0.456], Study 2). Black line indicates line of best fit for Motivational Intensity$_{combined}$. Red line indicates line of best fit for Valence$_{combined}$. Motivational Intensity$_{combined}$ is the average of Motivational Intensity$_1$ and Motivational Intensity$_2$. Valence$_{combined}$ is the average of Valence$_1$ and Valence$_2$. Motivational intensity rating range: -4 (*avoid*); 0 (*neutral*); +4 (*approach*).

We calculated the correlation between the mean RT for each picture (averaged across blocks and across participants). This revealed a strong correlation between Motivational Intensity$_{combined}$ and Valence$_{combined}$, r(98) = .77, p <.001, [95% CI = .68 to .84] (see Figure 3.10). Using the attenuation-correction formula to correct for the imperfect reliability of the individual measures, the corrected estimated correlation is $r_{\text{true}} = \frac{.77}{\sqrt{.80 \times .79}} = .97$. This indicates

that we found a high degree of correspondence between motivational intensity and valence for our implicit measure.

Figure 3.10 *Motivational Intensity$_{combined}$ Against Valence$_{combined}$*



Note. Scatterplot of Motivational Intensity$_{combined}$ against Valence$_{combined}$ ($r(98) = .77$, $p < .001$). Black line indicates line of best fit.

3.11 General Discussion

The present studies assessed the relationship between motivational intensity and the established dimensions for understanding emotion and its effect on cognition: valence and arousal. This served two purposes. First, it allowed us to assess the claim that the *arousal* associated with the emotion induced by a stimulus is an appropriate proxy for operationalising the motivational intensity of that emotion, and second, it allowed us to determine whether there is validating evidence that motivational intensity exists as a viable construct distinct from valence and arousal. To test this, we collected ratings of motivational intensity, valence, and arousal for a large and diverse range of picture stimuli, predominately selected from the widely used and validated (for valence and arousal) IAPS database, and then assessed the associations

between the different rating dimensions. We found a very high degree of association between motivational intensity and *valence*, and a more moderate relationship between motivational intensity and arousal. This high correspondence was true both when participants provided explicit ratings of valence and motivational intensity for the images, and also when we quantified valence and motivational intensity implicitly via RT in a classification task. Altogether, this calls into question the use of arousal as a proxy for motivational intensity, and indeed, more critically, challenges whether motivational intensity has sufficient merit as a construct to be considered distinct from valence at all. Motivational intensity may be valence by another name. This casts doubt on whether motivational intensity can make a useful unique theoretical contribution when it overlaps so fully with the well-established theoretical dimension of valence (Bradley & Lang, 2007a; Russell, 1980). These implications are discussed more fully in the following two sections.

3.11.1 Should Arousal be Used as a Proxy for Motivational Intensity?

Researchers have suggested that arousal is an appropriate proxy for motivational intensity, in that high arousal states correspond to high motivational intensity states, and low arousal states to low motivational intensity states (Gable & Harmon-Jones, 2008a, 2010c; Harmon-Jones et al., 2011b). Previously the proponents of motivational intensity have claimed that arousal is a distinct construct from motivational intensity, stating that, “unlike arousal, motivation always has action implications (even if they are vague)” (Gable & Harmon-Jones, 2013, page. 345), and their rationale is based on a suggestion from Bradley and Lang (2007a) work. However, the proponents used arousal as a proxy of motivational intensity, whereby they used IAPS ratings of arousal to represent levels of motivational intensity (e.g., low arousal = low motivational intensity, Gable & Harmon-Jones, 2010a).

The reliance on arousal ratings likely stems from the absence of systematic ratings of motivational intensity akin to those available for valence and arousal when the construct was

introduced into the literature. However, we argue that any claim about the purported relationship between arousal and motivational intensity is untenable in the absence of a comparison between systematic arousal and motivational intensity ratings to a large set of pictures, such as those that we provide here.

Our results indicated that motivational intensity and arousal have only a modest relationship. Moreover, although a relationship was shown between avoidance motivation and arousal, an inverse relationship (Study 1a) and no relationship (Study 1b) was observed between approach motivation and arousal. Overall, this indicates that arousal is not an appropriate proxy for motivational intensity, as the relationship would have to exist in both motivational directions for arousal to be considered an appropriate proxy for motivational intensity. This undermines the utility of arousal as a proxy for motivational intensity. Instead, the *valence* ratings of the feelings elicited by each picture had a much stronger and more consistent correspondence with the motivational intensity ratings that different individuals provided in response to that same picture. If anything, valence ought to be the proxy for motivational intensity. However, the overlap between motivational intensity and valence was so large and extensive, it calls into question whether motivational intensity should be considered distinct from valence at all.

3.11.2 Is Motivational Intensity Distinct from Valence?

Results demonstrated that motivational intensity and valence are *very* closely related. Indeed, in Study 1b, the correlation between participants' ratings of the motivational intensity evoked by the pictures and their valence ratings was approaching a perfect correlation (r = .96), and was on a par (indeed numerically higher) than the correlation between IAPS valence and the present study valence dimensions (r = .95) – a correlation between two different studies rating the *same* construct (valence). Similarly, in Study 1a, the absolute value of the correlations between the separate dimensions of motivational intensity and valence were in

excess of .9. This correspondence is striking in light of the fact that a different group of participants provided the motivational intensity versus valence ratings of the pictures. Furthermore, in Study 2, there was a strong correlation (r = .77), which was also extremely strong when corrected for the observed reliability of the RT measures (r = .97). This presents a serious challenge to the validity of motivational intensity as a construct distinct from valence It would appear that motivational intensity and valence are not distinct constructs. Instead, it may be that motivational intensity is a response to valence. Indeed, the intimate link between valence and motivational intensity, such that positive valence drives approach motivation and negative valence avoidance motivation is identified in early models of the architecture of emotion (Watson, 2000).

It should be kept in mind, however, that while this study collected ratings from a large set of pictures, a limitation is that the full gamut of human emotions is not captured. It is possible that a clearer divergence between motivational intensity and valence occurs for emotions not captured in these studies. For instance, it is difficult to evoke *anger* via IAPS pictures (Mikels et al., 2005), and this is one of the forms of emotional experience that has been suggested to differentiate valence from motivational intensity, such that it is a negative-valence but high in *approach* motivational intensity (e.g., Carver & Harmon-Jones, 2009; Gable et al., 2015). However, this divergence is a claim, and one that remains minimally tested, and when it is tested, the evidence contradicts this claim. For example, the ratings of motivational to approach or avoid in response to a single film that was designed to be anger-inducing do not support the claim that anger is associated with approach motivation (Gable et al., 2016; Gable et al., 2015) Indeed, in Gable et al. (2016), participants clearly indicated that anger was associated with avoidance, not approach motivation. This is critical, because the proponents of motivational intensity argue that anger is negative valence but approach motivated, and therefore any effects of anger on cognition or frontal cortical asymmetries as measured by EEG

need to be explained by the variable motivational intensity, rather than valence. We do not believe that there is sufficient evidence for this assertion given the limited ratings data available in the literature so far which appear to contradict this claim, and the current results suggest a very high degree of overlap between motivational intensity and valence. However, we did not specifically include anger manipulations here, and so it is theoretically possible that some categories of emotion such as anger could produce a divergence between valence and motivational intensity, and this awaits future research in which a large range of stimuli including those that evoke anger are rated with respect to valence and motivational intensity.

3.11.3 Implications

If motivational intensity is not truly distinct from valence, then this has significant implications for the field's understanding of how emotion and motivation impact cognition. It is possible that previous attempts to operationalise motivational intensity actually reflected different extremities of valence, in contrast with the focus of previous theories which were based on the direction of valence, and therefore, it was varying extremities of valence that were responsible for the observed effects on attentional and cognitive broadening/narrowing. For example, in one of the original papers that claimed to investigate motivational intensity (Gable & Harmon-Jones, 2010a), participants viewed pictures that were sad, disgusting, or neutral, and then completed a task designed to measure attentional breadth. Those who viewed the sad pictures were found to have broader attention when they viewed the sad pictures compared with the neutral pictures. However, those who viewed the disgusting pictures were found to have narrower attention when they viewed the disgusting pictures compared to when they viewed the neutral pictures. Gable and Harmon-Jones attributed this to the *disgusting* pictures having stronger motivational intensity than the *sad* pictures. However, the alleged relationship between disgust and sadness on the one hand and motivational intensity on the other was assumed, not validated. Instead, if extremity of valence mediates the relationship between

emotion and attention, the results could reflect the disgust pictures having more extreme negative valence than the sadness pictures. In support of this idea, the ratings obtained in that study indicated that the disgust pictures elicited more feelings of unpleasantness than did the sad pictures (Gable & Harmon-Jones, 2010a). In this light, it is interesting that in the early studies, there was never a direct comparison between different-valence stimuli (e.g., positive and negative together), only between same-valence stimuli (e.g., both negative, with what was thought to be different motivational intensities) (e.g., Gable & Harmon-Jones, 2008a, 2010a). It appears that the implicit assumption here is that all positive valence stimuli belong to a monolithic category of *positive* and all negative valence stimuli belong to a monolithic category of *negative*, which is not the case. Instead IAPS and other systematic rating studies have shown that there are degrees of positive valence, and two stimuli can both be positive in nature, but one relatively more positive than the other. Such gradations in valence have not always been accounted for in studies that have sought to test the effect of motivational intensity on cognitive or neuroscientific outcome variables, and so it is entirely possible that more extremely valenced stimuli (i.e., extreme positive and extreme negative) narrow attentional breadth whereas more intermediate valences (close to neutral) broaden it. This is an interesting possibility to be tested systematically in future research. Altogether, this demonstrates how the results attributed to motivational intensity might actually reflect valence. Of course, this remains speculation, and the actual driver of the emotion-cognition nexus awaits systematic testing in which the different dimensions are validly operationalised and directly pitted against one another. The present study highlights the need for such testing using systematically rated pictures rather than relying on assumptions – and the ratings we have collected here can be used for this purpose.

In summary, it has been claimed that motivational intensity is the driver of emotion-cognition effects, and it has also been suggested that arousal could be used as a proxy for motivational intensity when selecting stimuli for research. We present systematic evidence that

challenges both of these claims. First, we found that motivational intensity was much more closely aligned with valence than arousal. Second, the relationship between motivational intensity and valence was so strong, and the overlap so large, that it calls into question whether motivational intensity is indeed distinct from valence, or simply valence given another name. Motivational intensity is a theoretical construct that has had a substantial impact on theorising about how emotion affects cognition. If it is not truly a distinct construct, then all of the previous studies, behavioural and neuroscientific, which have claimed to reflect the influence of motivational intensity need to be reconsidered. In particular, it needs to be considered whether extremity of valence may instead be a better theoretical explanation for these observed results. Therefore, the present findings have potentially significant and far-reaching implications for understanding human emotion and cognition.

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Chapter 4: Motivational Direction Diverges from Valence for Sadness, Anger, and Amusement: A Role for Appraisals?

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4.1 Abstract

Recent work has cast doubt on whether the strength of motivation (strength of avoidance or approach tendencies) experienced while viewing emotion-eliciting pictures is dissociable from felt valence (negative versus positive). The present study extended this work by testing specific discrete emotions (amusement, anger, awe, desire, sadness) previous work has proposed separate motivational direction (avoid versus approach) from valence. In Study 1, participants (N = 60) rated the motivational direction or valence they experienced while viewing 100 pictures that each evoked one of the five discrete emotions. We found significant differences between average motivational direction and valence ratings for sadness, anger, and amusement. Critically, underlying these averages, we found that while valence responses were highly consistent, there was large variability in motivational direction, with some people indicating they wanted to approach and others indicating they wanted to avoid while viewing the same picture. Individual differences in motivational direction were largest for sadness, so in Study 2 (N = 100) we tested whether they were predicted by appraisals of the situation (e.g., ratings of how welcome or useful people believed their help would be). The three appraisals tested accounted for 64% of the variance in motivational direction, after which valence made a very small unique contribution. These findings highlight that motivational direction and valence can diverge. Given the variability in individuals' motivational direction responses, future studies designed to assess the effects of motivational direction on cognitive processes need to tailor stimuli for each participant to ensure they activate the intended motivational direction.

Keywords: motivational intensity; motivational direction; valence; appraisals; individual differences.

4.2 Motivational Direction Diverges from Valence for Sadness, Anger, and Amusement: A Role for Appraisals?

The motivational dimensional model of affect proposes that the motivation to approach or avoid is an important aspect of affect (Gable & Dreisbach, 2021), in addition to valence (negative/positive) and arousal (calm to excited/agitated), which has the potential to explain cognitive processes (e.g., attentional breadth, memory, and cognitive categorisation; for reviews, see Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013). However, this motivation-based dimension is missing some of the crucial foundational work that establishes it empirically. Instead, studies aiming to manipulate motivation have relied on theoretical ideas about the motivation stemming from specific discrete emotions, or untested proxies, such as arousal (Gable & Harmon-Jones, 2008a, 2010a, 2013). We recently sought to conduct this much-needed empirical work for the motivation-based dimension, and observed an overwhelming correspondence between the strength of motivation (strength of avoidance or approach tendencies) and valence (how unpleasant to pleasant the feeling was) for a diverse set of 300 emotional picture stimuli (Campbell et al., 2021). This result calls into question whether motivation is truly dissociable from valence. However, an important limitation of this work is that it did not test whether clearer divergences would emerge for some key discrete emotions (specifically, amusement, anger, awe, desire, and sadness) that have been said to separate motivational direction (avoidance or approach tendencies) from valence (Campbell et al., 2021; Carver & Harmon-Jones, 2009; Kaczmarek et al., 2021). We sought to rectify this in the present study.

4.3 Issues with the Operationalisation of the Motivation-based Dimension

The motivational dimensional model of affect espouses that motivation extends in two directions, *approach motivation* and *avoidance motivation,* and that both motivational directions can range from low-high in their respective intensities, called *motivational intensity*

(Gable & Harmon-Jones, 2010d; Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012). While approach versus avoidance are sometimes treated as categorical, it is clear these motivations exist along continuums (e.g., some emotions can have greater approach related motivation than others) (e.g., Campbell et al., 2021), and thus we take a dimensional approach here (considering the strength or degree of motivational direction).[5] The distinction between the dimensions of motivational intensity and motivational direction is important, as each is claimed to play an important role in driving specific cognitive domains (Harmon-Jones & Gable, 2018; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012). For example, the motivational intensity model of cognitive scope claims that motivational intensity—the **strength of tendencies (low/high)** irrespective of whether they are to approach or avoid—drives the broadening and narrowing of *cognitive scope* (Harmon-Jones et al., 2013), such that low motivational intensity is thought to broaden cognitive scope, and high motivational intensity is said to narrow it. Cognitive scope is an umbrella term used to describe the expansion and retraction of cognitive processes including, cognitive categorisation (Price & Harmon-Jones, 2010), memory (Gable & Harmon-Jones, 2010b; Threadgill & Gable, 2019b), and attentional breadth (Gable & Harmon-Jones, 2008a, 2010a, 2011b). In contrast, other models claim that motivational direction (approach *versus* avoidance motivation) drives other cognitive outcomes, including time perception (Gable et al., 2016; Gable & Poole, 2012) and asymmetrical cortical activity (for a review, see Harmon-Jones & Gable, 2018). For example, approach-related motivational states (e.g., anger, sadness) are said to shorten the perception of time relative to avoidance-related motivation (e.g., disgust). Both motivational intensity and motivational direction are said to be dissociable from valence (e.g., a negative emotion like anger can be associated with strong approach

[5] Here, we use the term motivational direction, with a focus on individuals' strength of tendency to approach or avoid. In Campbell et al. (2021), we used the more general term motivational intensity, but intended for it to refer to motivational direction as it is defined herein.

motivation), and according to these models, it is the motivation, not the valence or arousal of an emotion, that drives cognitive processes.

Despite the clear theoretical importance of motivational intensity and direction, there are crucial limitations in how these constructs have been operationalised and empirically validated. Unlike the dimensions of valence and arousal, which have been formally operationalised via ratings, and in turn have been validated by a wide array of physiological responses (e.g., Bradley, Codispoti, Cuthbert, et al., 2001; Bradley et al., 2006; Bradley, Codispoti, Sabatinelli, et al., 2001; Bradley et al., 2007; Bradley & Lang, 2007b; Bradley et al., 2008; Cuthbert et al., 2000; Grühn & Scheibe, 2008; Lang et al., 1997, 2008), this kind of foundational work is missing for motivation. Instead, studies have made a variety of untested assumptions about motivation when manipulating it experimentally. For example, some studies have made the unsubstantiated assumption that motivational intensity and arousal are so closely related that it is appropriate to use arousal as a proxy for motivational intensity (Gable & Harmon-Jones, 2008a, 2010a, 2013; Threadgill & Gable, 2019b). Alternatively, some studies used stimuli designed to elicit discrete emotions (e.g., fear, disgust) that are theorised to have a particular motivational intensity or direction without empirical evidence linking the discrete emotions to motivation. For example, studies have assumed that disgust is higher in motivational intensity than sadness (Gable & Harmon-Jones, 2010a), or that sadness and anger both elicit approach motivation while disgust elicits avoidance motivation (Gable et al., 2016; Gable et al., 2015). Given this limited foundational work supporting the concepts of motivational intensity and direction as distinct constructs from valence and arousal, we recently conducted a study where participants rated the emotion they experienced in response to a diverse range of 300 emotional pictures, with different participants providing ratings along the dimensions of motivational direction, valence, and arousal (Campbell et al., 2021). We found an overwhelmingly high correspondence in how different participants rated the pictures on the

dimensions of motivational direction and valence (correlation coefficients greater than .9), while the relationship between motivational direction and arousal was not as pronounced. In other words, if one group of participants considered a picture as eliciting strong positive *valence*, then another group of participants would rate this picture as high in approach-related *motivational direction*, and if one group of participants considered a picture as eliciting strong negative *valence*, then another group of participants would rate this as high in avoidance-related *motivational direction*. This correspondence is particularly striking given different participants provided the motivational direction and valence ratings, and thus responses could not be contaminated by response history for the other dimension. If so, then it is not clear if there is a need for the newer motivation-based dimension, if it can be subsumed under the existing well-validated one of valence (Campbell et al., 2021).

However, while in Campbell et al. (2021) we used pictures that evoked emotions with a wide range of valence scores, we did not aim to capture key discrete emotions that have been said to separate motivational direction from valence (specifically, amusement, anger, awe, desire, and sadness) (e.g., Kaczmarek et al., 2021). It is unlikely that many or even any of our pictures in our study (Campbell et al., 2021) elicited feelings of *anger*. Anger is one discrete emotion that has been hypothesised to cleave motivational direction from valence, because anger is claimed to evoke negative valence but high approach motivation (e.g., when you feel the urge to confont someone; Gable & Dreisbach, 2021; Gable et al., 2016; Gable et al., 2015). The other four key discrete emotions, which have been identified in previous literature as potential separators of motivational direction and valence include amusement, awe, desire, and sadness (Gable & Harmon-Jones, 2008a; Kaczmarek et al., 2021). In particular, it has been found that amusement makes individuals feel positive, but a low urge to approach (e.g., self-deprecating humour) (Kaczmarek et al., 2021), indicating that positive valence does not always go hand-in-hand with an urge to approach. Awe makes people feel positive but could plausibly

also entail either an urge to avoid (e.g., a tiger with its cubs or impending doom) or approach (e.g., a mesmerising sunset) (Kaczmarek et al., 2021). Desire makes individuals feel positive but could also induce an urge to avoid (e.g., when a person on a diet sees a dessert) (Gable & Harmon-Jones, 2008a), and sadness can make individual's feel negative but also an urge to approach (e.g., when seeing a child cry).

Despite these claims, there is little work that directly gauges both degree of motivational direction and valence ratings of emotions induced by such stimuli to verify these claims, with the exception of a recent study that aimed to test this directly (Kaczmarek et al., 2021). However, Kaczmarek et al. (2021) only used one stimulus per discrete emotion, and here, we sought to use a range of stimuli to induce five key discrete emotions that have been identified in previous literature (Carver & Harmon-Jones, 2009; Gable & Harmon-Jones, 2008a; Kaczmarek et al., 2021) as potentially distinguishing motivational direction from valence, and assessed whether explicit ratings on these dimensions converged as they did in our previous work (Campbell et al., 2021), or diverged as has been suggested in other previous work (Kaczmarek et al., 2021).

4.4 The Present Study

The primary aim of the present work was to assess whether the degree of motivational direction (avoid versus approach motivation) and the degree of valence (negative versus positive feeling) converge or diverge across specific discrete emotions for which motivational direction and valence are thought to diverge: amusement, anger, awe, desire, and sadness. Therefore, in Study 1, we sought to elicit these five key discrete emotions to determine whether the convergence between motivational direction and valence that we obtained in our previous study (Campbell et al., 2021) would also occur for these discrete emotions. That is, the aim was to test whether these emotional states produced convergent or divergent responses along

the dimensions of motivational direction and valence. This approach represents an important further test of the relationship between motivational direction and valence.

Therefore, in Study 1, different groups of participants were asked to either rate 100 pictures on their experience of motivational direction, or the same 100 pictures on their experience of valence. Correlational analyses and a mixed between-within subjects ANOVA were then used to identify which (if any) discrete emotions demonstrate a divergence/convergence between motivational direction and valence.

4.5 Study 1: Do Motivational Direction and Valence Converge or Diverge for Amusement, Anger, Awe, Desire, and Sadness?

4.5.1 Method

4.5.1.1 Transparency and Openness. We report how we determined our sample size, data exclusions, manipulations, and measures in the study, and we follow JARS (Kazak, 2018). All data and research materials are available at Open Science Framework (OSF) and can be found at https://osf.io/b239k/. Data were analysed using SPSS, version 27 and JMP, version 15.0.0. The design of Study 1 and Study 2 and their analysis were not pre-registered.

4.5.1.2 Participants. Sixty participants comprised two randomly assigned groups of 30 valence-raters (10 men, 20 women; M_{age} = 20.23 years, SD_{age} = 2.69, $range_{age}$: 18-31; 26 heterosexual, 1 bisexual, 1 asexual, 1 homosexual, 1 other) and 30 motivational direction-raters (14 men, 15 women, 1 non-binary/other; M_{age} = 19.67 years, SD_{age} = 1.47, $range_{age}$ = 18-24; 23 heterosexual, 5 bi-sexual, 2 homosexual). Sample size was set at 30 per group on the basis that a *minimum* number of 20 participants is needed to stabilise mean ratings (DeBruine & Jones, 2018).

In both studies, participants were recruited from the Australian National University (ANU) online recruitment website (SONA) and were compensated by way of course credit. Inclusion criteria required that participants be born and raised in a Western country (e.g.,

Australia, New Zealand, US, UK, Canada) because responses to the pictures might differ across cultures (Huang et al., 2015), and have English as their first language. Participants were required to be at least 18 years old due to the sensitive nature of some of the pictures (e.g., erotica), and a maximum of 40 years old because age impacts emotional processing (Glinka et al., 2020). We also wanted ratings to reflect neuro-typical responses, and thus we required that participants had not received a diagnosis of ADD/ADHD, Autism Spectrum Disorders, Schizophrenia, or any major neurological illnesses requiring hospitalisation (e.g., Teh et al., 2018). We included questions in a demographics questionnaire that screened for the above inclusion criteria, and individuals were excluded from the final participation sample if they did not meet these criteria. Participants were those individuals who gave consent, met inclusion criteria, and completed the study. Both studies were conducted in compliance with ethics protocol 2019/162 approved by the ANU Science and Medical Delegated Ethical Review Committee.

4.5.1.3 Stimuli. In total, 100 pictures (20 pictures per discrete emotion; see Supplementary F for list of picture names) were selected based on pilot testing (see Supplementary A for methods, and full results). We used a power analysis to determine the appropriate number of pictures for each discrete emotion to be used in Study 1. G*Power's (Faul et al., 2009; Faul et al., 2007) bi-serial a priori function indicated that we required a sample of $N = 4$ to achieve a power of .8 ($\alpha = .05$, two-tailed) and an effect size equivalent with that seen for the relationship between motivational direction and valence ($r = .96$, from Campbell et al. (2021)). To be selected for Study 1, we required that at least 65% of pilot participants labelled the picture as showing the intended discrete emotion and rated it 4 or higher on scale measuring emotional intensity from 1 *(no emotion*) to 9 *(extreme emotion*).

4.5.1.4 General Procedure for Studies 1 and 2. Participants completed this and the subsequent study fully-online via Qualtrics. At the beginning of both studies, participants were

instructed to resize their screen to match a rectangular shape presented onscreen to the size of a standard credit card. This ensured that the pictures would be presented at a standard size across devices (8 cm wide and 8 cm high for landscape and portrait pictures, respectively). This standard size was chosen such that the pictures and rating scales would fit on the screen without having to scroll, and not too small so that the picture would be hard to process. We checked that this was the case across a variety of different screen sizes, both desktop and laptop. Participation was limited to completion on computers and tablets (i.e., no mobile phones or iPads).

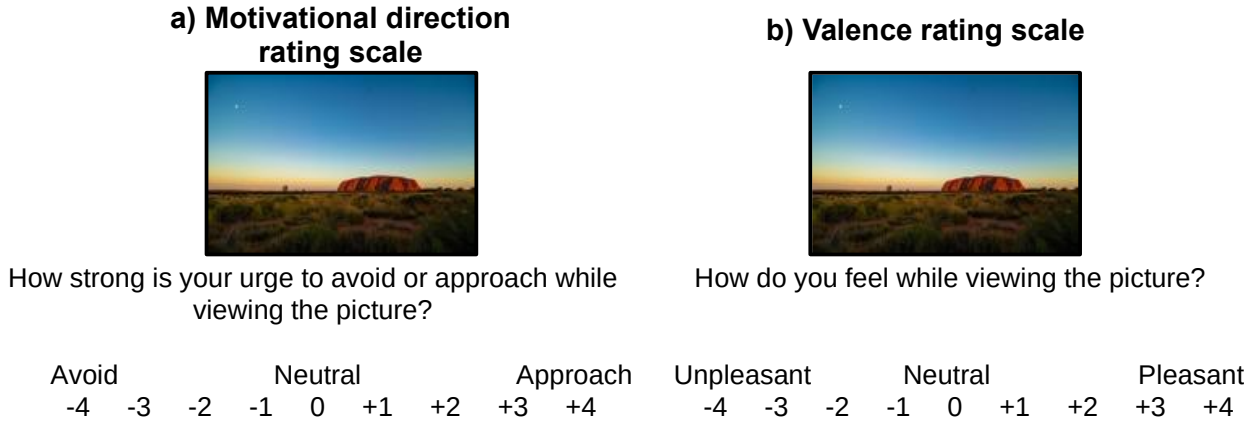
Before starting, participants were given explicit warning about the nature of the pictures they would see (i.e., pictures of mutilated bodies, deceased individuals, frightening animals, political symbols such as swastikas, racist and homophobic imagery, and semi-naked and naked same-sex and opposite sex couples engaged in romantic and sexual acts). Demographic information was also collected before participants rated the pictures (age, identified gender, identified sexual orientation, dominant handedness, country of birth, country spent most time in, first language, normal or corrected-to-normal vision, any diagnosis of ADD/ADHD, Asperger's Disorder or another Autism Spectrum Disorder, Schizophrenia, any major neurological illness (e.g., Parkinson's disease, stroke, or any major head injury requiring hospitalisation)).

4.5.1.5 Study 1 Picture Ratings. Figure 4.1 illustrates how participants rated the 100 pictures (see Supplementary E for full instructions). Participants were randomly allocated to rate either motivational direction or valence. First, to familiarise participants with the rating scales, they viewed and rated the same 10 practice pictures from the Internet used in the pilot study that were selected to represent the five discrete emotions (two pictures per discrete emotion). Then, participants proceeded to rate the 100 test pictures one by one. Each picture remained onscreen until response. If a participant clicked to move onto the next picture before

responding, a response was requested but not forced before continuing to the next picture. The order of the 100 test pictures was fully randomised for each participant.

4.5.1.6 Post-Test Positive Mood Induction. After completing the experimental block, participants were shown 20 mildly positive pictures from the Internet. These pictures were intended to mitigate any effect of exposure to the negative pictures.

Figure 4.1 *Example Stimulus and Rating Scale Used in Study 1*



Note. (a) Motivational Direction rating scale with a neutral point (0) included. (b) Valence rating scale with a neutral point (0) included. The example stimulus shown here is from the Internet (https://unsplash.com/photos/WEtXkeIlMoM) and is not an actual IAPS, NAPS, or NAPS ERO because they cannot be published. However, this picture illustrates the type of picture used in our study to evoke 'awe'.

4.5.1.7 Data Screening. Overall, 0.1% of individual rating scores were missing across the 60 participants. We calculated an average rating for each picture using the remaining data (minimum number of ratings per picture = 28). We assessed the normality of motivational direction and valence ratings for all 100 pictures together and for each set of 20 pictures separately (e.g., valence ratings for amusement pictures). Valence ratings were non-normally distributed, suffering from significant kurtosis (skew or kurtosis *z*-scores > 3.29). However, motivational direction and valence ratings were both normally distributed for all five sets of 20 pictures individually. Therefore, for consistency, parametric analyses were used for all

correlational analyses. Note, non-parametric correlations across the total 100 pictures were substantively the same as the parametric ones (see Supplemental Table S2).

4.5.1.8 Data Analysis. Following (Campbell et al., 2021), we calculated correlations between motivational direction and valence for the total 100 pictures. We also calculated correlations between motivational direction and valence for the 20 pictures showing each of the five discrete emotions. To facilitate interpretation of these correlations, we also examined the internal consistency of our ratings using Cronbach's α. The maximum correlation that can be observed between two variables is constrained by the measurement reliability of both variables. This is quantified in Spearman's attenuation-correction formula (i.e., $r_{\text{true}} = \frac{r_{\text{observed}}}{\sqrt{r_{xx'} r_{yy}}}$) (Parsons et al., 2019; Spearman, 1904). Therefore, we reported the r_{true} for each of the primary analyses in this and all subsequent studies in addition to uncorrected *r*. We also ran a mixed ANOVA (within-subjects variable: rating type [motivational direction, valence]; between-subjects variable: discrete emotion [amusement, anger, awe, desire, sadness]) to examine if motivational direction and valence rating scales differed as a function of discrete emotion. For these analyses, pictures were our unit of analysis rather than participants.

4.5.2 Results and Discussion

4.5.2.1 Internal Consistency. Both the motivational direction rating scale and valence rating scale had excellent internal consistency (Cronbach's α = .92 and .9 respectively). We also examined the internal consistency of the motivational direction and valence rating scales within each of the five discrete emotions of interest. Both the motivational direction and valence rating scales had excellent internal consistency across all discrete emotions (all αs > .82, see Table 4.1).

Table 4.1 *Descriptive Statistics and Internal Consistency for the Motivational Direction and Valence Rating Scales for the Five Discrete Emotions in Study 1 (n = 20 Pictures Per Discrete Emotion)*

	Motivational Direction			Valence		
Discrete Emotion	*Mean*	*SD*	Cronbach's α	*Mean*	*SD*	Cronbach's α
Amusement	1.29	.49	.91	1.62	.21	.97
Anger	-2.16	.59	.88	-2.68	.46	.94
Awe	2.21	.77	.91	2.18	.54	.94
Desire	1.76	.54	.83	1.65	.51	.94
Sadness	-.92	.62	.95	-2.19	.39	.91

Note. Means represent the total average of all 20 picture rating averages belonging to that discrete emotion (e.g., motivational direction amusement average = average of all amusement pictures motivational direction averages).

4.5.2.2 Relationship between Motivational Direction and Valence Ratings for All 100 Pictures.

We first examined the relationship between motivational direction and valence ratings for all 100 pictures in Study 1. There was a very strong correlation between them, $r(98) = .95$, $p < .001$ [95% CI = .91 to .96], consistent with the findings in Campbell et al. (2021) ($r = .96$).

4.5.2.3 Relationship between Motivational Direction and Valence Ratings within Each Discrete Emotion.

We then examined the relationship between motivational direction and valence ratings for each of the five discrete emotions separately (see Table 4.2). There were strong correlations between motivational direction and valence for amusement, awe, and desire. There was a moderate correlation for sadness, but no significant correlation for anger (see Supplementary Table S1, and Table S2 for non-parametric Spearman's rho and r_{true} for discrete emotions).

Table 4.2 *Correlations between Motivational Direction and Valence Ratings for Study 1*

Emotion	Upper Bound *r*	*r*	*r* 95% CI	r_{true}
All Discrete Emotions Combined (*N* = 100 Pictures)	$\sqrt{.9\ x\ .92}$ = .91	.95**	.93, .97	$\frac{.95}{\sqrt{.9\ x\ .92}}$= 1.04
Amusement	$\sqrt{.97\ x\ .91}$ = .94	.74**	.44, .89	$\frac{.74}{\sqrt{.97\ x\ .91}}$= .79
Anger	$\sqrt{.94\ x\ .88}$ = .91	.32	-.14, .67	$\frac{.32}{\sqrt{.94\ x\ .88}}$= .35
Awe	$\sqrt{.94\ x\ .91}$ = .92	.81**	.57, .92	$\frac{.81}{\sqrt{.94\ x\ .91}}$= .88
Desire	$\sqrt{.94x\ .83}$ = .88	.79**	.53, .91	$\frac{.79}{\sqrt{.94\ x\ .83}}$= .89
Sadness	$\sqrt{.91\ x\ .95}$ = .93	.70**	.37, .87	$\frac{.70}{\sqrt{.91\ x\ .95}}$= .75

Note. For each discrete emotion, *N* = 20 pictures.
*p < .05 (2-tailed). **p < .01 (2-tailed).

4.5.2.4 Does Motivational Direction Diverge from Valence for Discrete Emotions?.

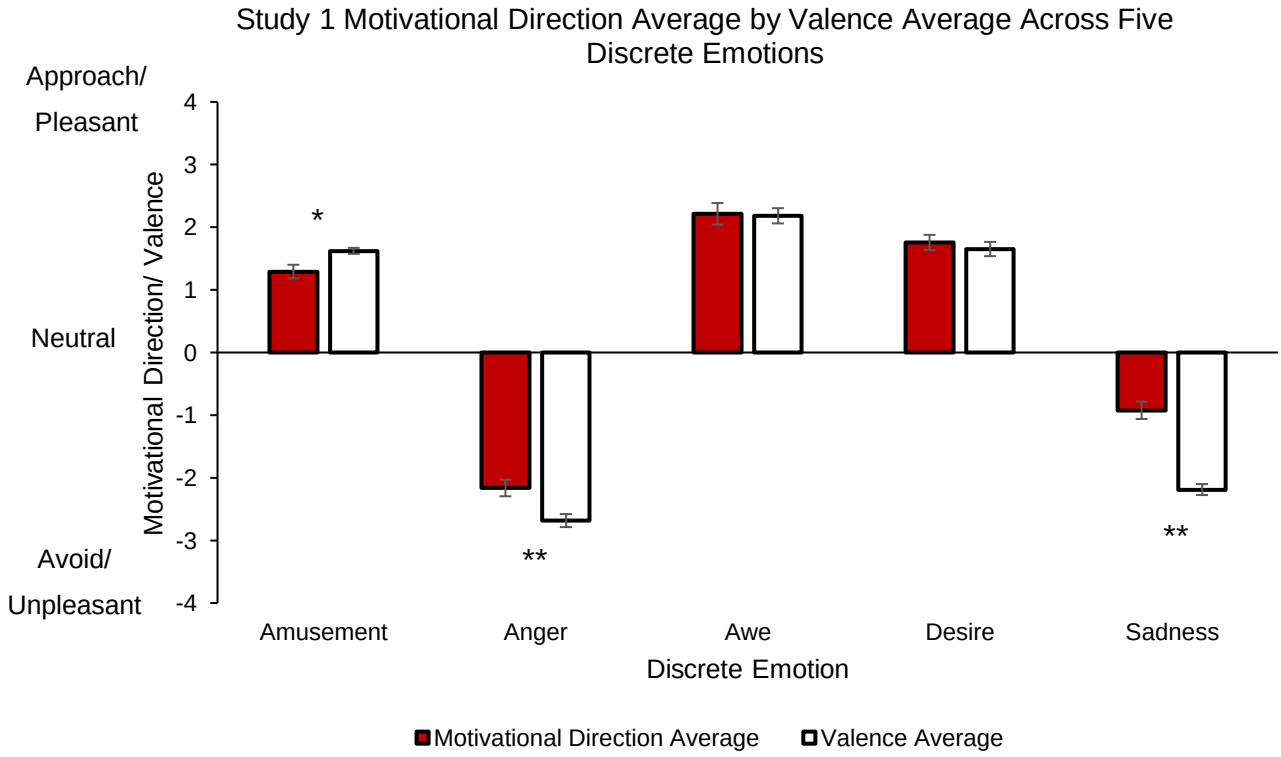
Figure 4.2 presents mean motivational direction and valence ratings for each of the five discrete emotions. For each discrete emotion, the totalled average of all 20 pictures picture average ratings is presented. Our core finding was that motivational direction diverged from valence for sadness, anger, and amusement, but not for awe nor desire. Although motivational direction and valence ratings were strongly correlated for amusing pictures (r = .74), indicating the rank-ordering of responses is preserved, the ANOVA showed motivational direction and valence values were not identical and differed on average. Statistically, this conclusion was supported by a significant interaction between rating type and discrete emotion, $F(4, 95) = 35.55$, p <

.001, η_p^2 = .60[6], and post-hoc paired-samples t-tests that compared motivational direction and valence ratings within each discrete emotion separately (ordered from largest to smallest difference): sadness, $M_{difference}$ = ±1.27, p < .001, [95% CI = ±1.47, ±1.06]; anger, $M_{difference}$ = ±.52, p < .001, [95% CI = ±.72, ±.32]; amusement, $M_{difference}$ = ±.33, p = .002, [95% CI = ±.13, ±.53]; desire, $M_{difference}$ = ±.11, p = .307, [95% CI = ±.31, ±.10]; and awe, $M_{difference}$ = ±.03, p = .762, [95% CI = ±.23, ±.17] (see Supplementary H for a closer look at sadness, anger, and amusement).

4.5.2.5 Divergences between Motivational Direction and Valence on Unipolar Scales of Approach Motivation, Avoidance Motivation, Positive Valence, and Negative Valence. In this study we used bipolar measures of motivational direction and valence. To determine whether the use of unipolar measures of motivational direction and valence would produce converging or contrasting results, we ran an additional study where we replicated Study 1 using four new unipolar measures (a single scale each for approach motivation, avoidance motivation, positive valence, and negative valence). Divergences between motivational direction and valence for discrete emotions was supported when unipolar measures of approach motivation, avoidance motivation, positive valence, and negative valence were used in an additional study. At its core, the additional study produced the same outcomes as observed in Study 1 and supported the use of bipolar motivational direction and valence scales in Study 1 and 2. Please see Supplementary B for the rationale, methods, results and discussion for outcomes of retest of Study 1 using unipolar measures of motivational direction and valence.

[6] Levene's test indicated unequal variances for Valence Average (F = 3.11, p = .019). However, ANOVA is robust to these violations provided the size of groups are similar, and in our case all groups had an equal size of 20.

Figure 4.2 *Mean Motivational Direction and Valence Ratings for the Five Discrete Emotions*

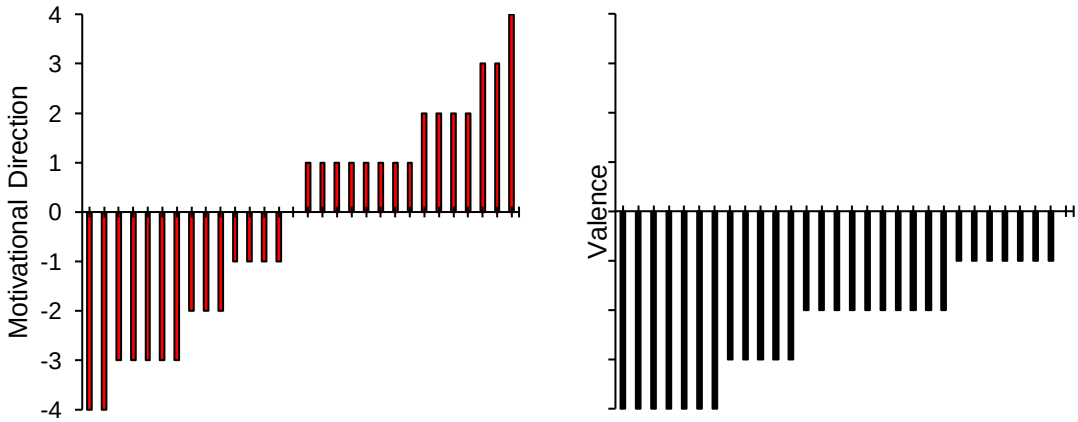


Note. Error bars = standard error of mean. Means represents the total average of all 20 picture average ratings within that discrete emotion.
*mean difference sig. at p = .05. **mean difference sig. at p = .001.

4.5.2.6 Individual Differences in Participants Motivational Dimension Responses to Pictures. While examining the histograms of individuals' responses to each picture we observed that there was notable individual variance across participants responses for some pictures on motivational direction (e.g., to the same picture, some participants felt an urge to avoid, and some felt an urge to approach) but not valence polarity (e.g., to the same picture, most participants felt negative). See Figure 4.3 for an example of differences in variance of ratings across motivational direction and valence for one sad picture. During re-analyses of Campbell et al. (2021), differences were also observed for some groups of pictures (e.g., pictures of erotica and pictures that were intended to evoke sadness where there was a mix between avoidance and approach responses; see Supplemental Data File 4).

To statistically measure the variance in participants' responses to each picture across motivational direction and valence polarity in the present study, we conducted a mixed ANOVA with rating scale (motivational direction, valence) as the repeated-measures variable and discrete emotion (amusement, anger, awe, desire, sadness) as the between-subjects variable, and SD for each picture as the dependent variable. The mixed ANOVA revealed a significant interaction between rating scale and discrete emotion, $F(4, 95) = 17.01$, $p < .001$, $\eta_p^2 = .42$[7]. Post-hoc paired-samples t-tests that compared motivational direction and valence SDs within each discrete emotion separately (ordered from largest to smallest difference): sadness ($M_{difference} = \pm.90$, $p < .001$, [95% CI = ±.1.05, ±.74]), anger ($M_{difference} = \pm.64$, $p < .001$, [95% CI = ±.79, ±.48]), awe ($M_{difference} = \pm.31$, $p < .001$, [95% CI = ±.47, ±.15]), and desire ($M_{difference} = \pm.19$, $p = .017$, [95% CI = ±.35, ±.04]). There was no significant different between motivational direction and valence SDs for amusement ($M_{difference} = \pm.13$, $p = .108$, [95% CI = ±.29, ±.03]).

Figure 4.3 *Example of Individual Responses for 'People at Car Crash' Picture Stimuli from Study 1*



Note. Individual participant data from Study 1 for example picture, 'People at Car Crash'. Motivational Direction and Valence data are from different participants. Histograms for the remaining 19 sad pictures are in Supplement Figure S2.

[7] All variables (all discrete emotions combined motivational direction and valence SDs, and SDs for motivational direction and valence for each of the five discrete emotions) were normally distributed (skew and kurtosis *z-scores* < 3.29). Levene's test indicated unequal variances for Valence SD ($F = 3.52$, $p = .010$). However, we had equal size of groups (20 pictures per group), therefore ANOVA is robust to these violations.

4.5.2.7 Discussion. Overall, our analysis revealed that at the group level there was a divergence between motivational direction and valence for the discrete emotions' sadness, anger, and amusement. Moreover, when examining participants' responses to each picture, for some pictures (e.g., sad pictures), we saw smaller variance in valence responses (e.g., most participants rated the same picture as negative in valence polarity). However, for the same pictures we saw larger variance in their motivational direction responses (e.g., on the same picture participants ratings varied between avoidance and approach motivation). Analyses revealed that this heightened variability in motivational direction responses compared to valence responses was present for sadness, anger, awe, and desire.

A handful of previous studies have investigated individual differences in approach and avoidance motivation in response to emotion-eliciting stimuli (e.g., Gable & Poole, 2014; Harmon-Jones, 2007; Harmon-Jones & Gable, 2009; Zinner et al., 2008). For example, one study investigated whether individual differences in trait anger are associated with frontal cortical asymmetries in response to anger-eliciting stimuli (Harmon-Jones, 2007), and other studies have looked at the role of individual differences in approach motivation during dessert eating (Gable & Harmon-Jones, 2008b; Harmon-Jones & Gable, 2009). However, most of these studies focused on variation within a motivational direction (e.g., different magnitudes of approach), and did not collect ratings of motivational direction.

Given that motivational direction and valence can differ, what could be driving the motivational direction ratings, especially given the considerable individual variation in the motivational direction ratings? What could result in individuals responding so differently, i.e., some want to approach, and others want to avoid the same picture? It may be that appraisals of a situation are one of the fundamental underlying mechanisms driving motivational direction ratings in specific situations. Appraisal theorists propose that emotions evolve due to particular assessments of an event or situation (for a review, see Ellsworth & Scherer, 2003). For

example, a picture of a woman being dragged into a van, which typically evokes anger, may elicit approach motivation in one person because they feel that they can safely intervene in the situation and confront the attacker (e.g., if they are a physically strong person). However, avoidance motivation may be evoked in another person because they feel it is unsafe to intervene, and fear that they will also become a victim of the attack if they were to intervene. In another example, one person may wish to approach a sad crying child in hospital because they may be able to help the child, for example, when they have prior experience soothing children. However, another person may want to avoid this same situation if they have no experience soothing children and may therefore feel uncomfortable providing help. The appraisal that a person makes of a situation is unique to their own experience, and it is possible that appraisals are influenced by trait-level qualities, like those explored in previous individual differences studies (e.g., personality traits, attitudes, level of liking; Gable & Harmon-Jones, 2008b; Harmon-Jones, 2007; Zinner et al., 2008). However, the aim of Study 2 was to uniquely assess if helping appraisals in a sad situation influence an individual's tendency to approach or avoid.

4.6 Study 2: Do Appraisals of Helping Potential Predict Individual Differences in Motivational Direction for Sad Situations?

Here we examined whether individuals' appraisals could account for participants' variable motivational direction responses. While appraisals may predict motivational direction responses for multiple discrete emotions, the relevant appraisals for each discrete emotion will likely differ. Therefore, we sought to focus on a single discrete emotion in Study 2. We decided to focus on sadness because this discrete emotion elicited the greatest variability in motivational direction responses in Study 1. Given that the difference in variance was greatest for sad situations, the next step was to consider what might be driving these individual differences in participants' responses on motivational direction for sad situations specifically.

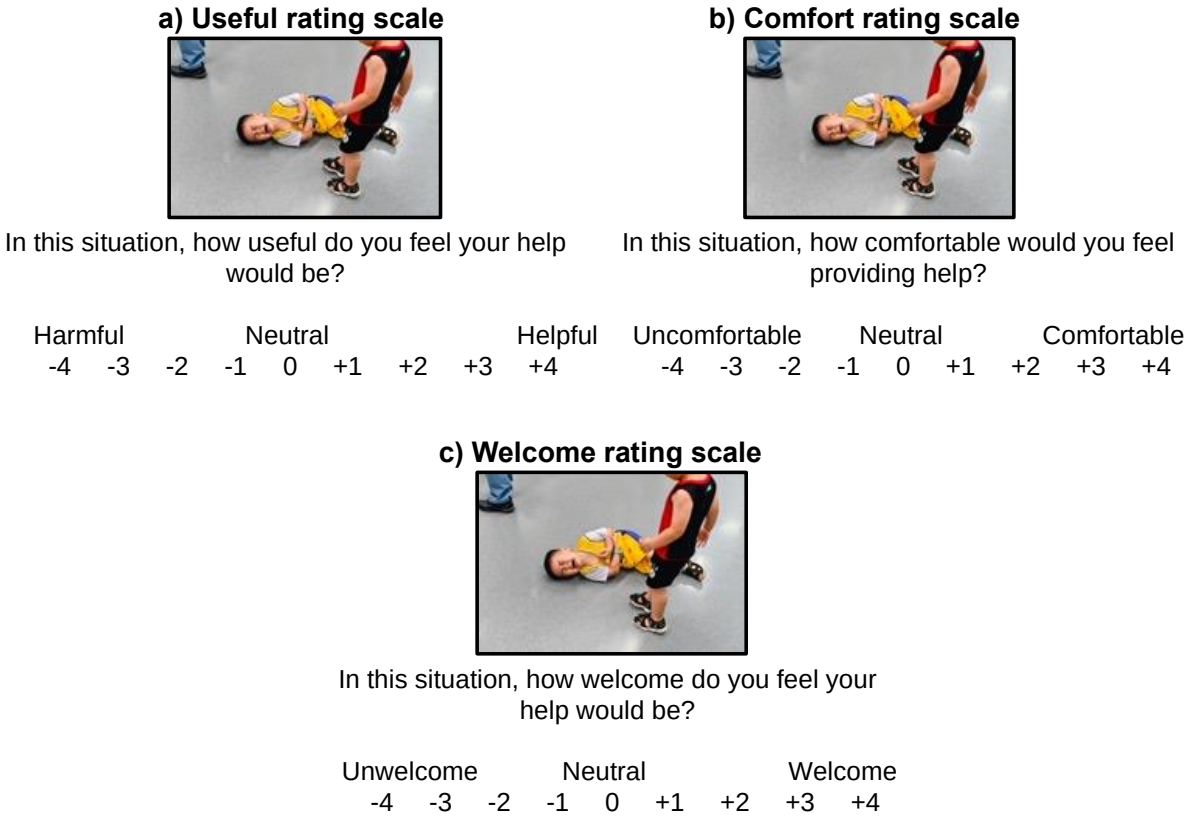
It is understood that negative emotions typically evoke avoidance motivation responses (Campbell et al., 2021), as most individuals want to avoid situations that cause unwanted emotional states (Markovitch et al., 2017). However, why do some individuals feel the urge to approach negative situations that make them feel sad?

It is possible that the appraisal of an individual's *helping potential* is a mechanism for approach motivation during sadness (Cialdini et al., 1987; Dawel et al., 2019). That is, when observers experience a situation that makes them feel sad, they make an evaluative assessment of their ability to help. If an observer determines that they can help in a situation, they may feel an urge to approach as a mode of providing help. For example, an individual may feel that they can aid an injured individual because they have experience with first aid, and therefore feel an urge to approach and help the person. However, if an individual determines that they cannot help in the same situation because they have no experience with first aid, then they may not experience an urge to approach. In Study 2 we aimed to test if helping-related appraisals motivate people to approach or avoid in sad situations.

It is likely that there are different considerations that come into play in a sad situation when individuals assess their helping potential. We developed three measures to represent appraisals of helping potential in sad situations. The first was developed to assess how useful the observer feels their help would be. The second is related to the observer's perceived safety in the situation, and is a measure of how comfortable the observer feels providing their help. The final appraisal of helping potential is how welcome the observer feels their help would be. We hypothesised that either one of these helping potential appraisals in isolation, or multiple appraisals in combination would predict participants responses of approach or avoidance motivation in sad situations. We also wanted to assess the predictive value of these appraisals in comparison to valence in explaining motivational direction. Therefore, the aim of this study was to determine whether participants' appraisals of their helping potential (e.g., whether it

would be useful or welcome) and/or valence could predict participants motivational direction responses during exposure to the sad situations used in Study 1.

Figure 4.4 *Example Stimulus and Rating Scale Used in Study 2*



Note. The example stimulus shown here is from the Internet (https://unsplash.com/photos/Z5Lsb65XoCE) and is not an actual IAPS, NAPS, or NAPS ERO because they cannot be published. However, this picture illustrates the type of picture used in our study to evoke 'sadness'.

4.6.1 Method

4.6.1.1. Participants. We recruited 100 participants (27 men, 73 women; M_{age} = 18.87 years, SD_{age} = 1.85, age_{range}: 18-32; 1 asexual, 17 bisexual, 76 heterosexual, 3 homosexual, 3 preferred not to disclose) from the ANU online recruitment website (SONA) who met study criteria and participated for course credit. We used the linear multiple regression fixed model, R^2 deviations from zero G*Power priori-test to determine the appropriate sample size for this study. To achieve a power of .8, with a medium effect size (f^2 = .15) with α = .05 we required

N = 85 (Faul et al., 2009; Faul et al., 2007). Therefore, our sample size of 100 participants exceeded the required power.

4.6.1.2 Stimuli and Procedure. In this study, each participant rated all 20 sad pictures used in Study 1 five times across five separate blocks. Each block presented one of the five rating scales (motivational direction, valence, how useful help would be, how comfortable they would feel providing help, and how welcome help would be). Block presentation was counterbalanced on Qualtrics to account for order effects. The scales used to measure motivational direction and valence were identical to those used in Study 1 (Figure 4.1a and 4.1b). The other scales were created for Study 2 to measure the three predicted appraisals of helping potential in response to the sad situations (i.e., pictures). The first measured how useful participants felt their help would be in the situation, from harmful (*-4*) to helpful (*+4*) with a neutral mid-point (*0*). The second measured how comfortable participants felt providing help, from uncomfortable (*-4*) to comfortable (*+4*) with a neutral mid-point (*0*). The third measured how welcome participants felt their help would be, from unwelcome (*-4*) to welcome (*+4*) with a neutral mid-point (*0*) (see Figure 4.4). Onscreen instructions were given on how to use each rating scale (see Supplementary I for full Study 2 instructions). For each block, participants practiced by viewing and rating two additional 'sad' pictures from the Study 1 pilot study to familiarise them with the task. Participants were then informed they would start the experimental trials. Each experimental block consisted of the same 20 sad pictures used in Study 1, each presented on the screen until response. If participants did not respond, a response was requested but not forced before continuing to the next picture. The order of the pictures was fully randomised for each block and for each participant. After completion of the ratings, the same post-test positive mood induction procedure was followed as in Study 1.

4.6.2 Results and Discussion

4.6.2.1 Data Analysis. We used JMP 15.0.0 to perform a linear mixed model (LMM) analysis to investigate the relationship between appraisals of helping potential (useful, comfort, welcome), valence, and motivational direction responses to 20 sad situations (pictures) across individuals. Motivational direction ratings were the dependent variable. As fixed effects, we entered appraisals (usefulness, comfort, and welcome) and valence into the model. We had two random effects: participants and stimuli.

To assess the contribution of the three appraisals and valence at the stimulus level, we ran post-hoc multiple regressions on each of the individual sad situations (one multiple regression for each of the 20 picture stimuli). We ran these additional analyses because in the LMM analysis we saw that our predictors varied across picture stimuli. All assumptions of multiple regression were met for each of the 20 multiple regressions, except for normality of residuals where there were minor deviations, but none were extreme, therefore unlikely to have had a significant impact on our results. Moreover, our criterion for homoscedasticity were observing the plots of standardized residuals vs. standardized predicted values, which showed no obvious signs of funneling. To account for the issue of multiple comparisons across our four predictors (our three appraisals and valence) in our multiple regressions, we used a Bonferroni correction for four predictors ($p < .013$). Please see Supplementary J for an analysis of gender differences in helping potential on motivational direction responses in sad situations.

Table 4.3 *Multiple Regression Models and Standardised Betas (β) Predicting Motivational Direction from Useful, Comfort, and Welcome Appraisals, and Valence, for Each Sad Stimulus*

		Predictors (β)			
Picture Description	Adjusted R^2	Useful	Comfort	Welcome	Valence
Blind/Starved Dog	.63***	.22*	.57**	.11	.02
Wounded Child	.48***	.25**	.26**	.26**	.14
People at Car Crash	.47***	.23*	.24*	.36**	-.01
Crying Boy	.45***	.11	.35**	.34**	-.12
Baby in Hospital	.42***	.16	.4**	.2	.07
Child Crying	.39***	.27*	.15	.33**	-.07
Senior Couple in Hospital	.38***	.26*	.42**	.08	-.09
Disabled Child	.38***	.14	.5**	.08	-.09
Accident	.37***	.22*	.5**	-.02	-.03
Scared Child	.36***	.35**	.11	.28**	-.07
Cemetery	.36***	.31**	.11	.31**	.11
Hospital	.35***	.16	.12	.33**	.24**
Sick Child	.33***	.19	.33**	.21*	-.12
Homeless Woman	.32***	.07	.57**	.00	-.00
Child in Hospital	.32***	.31**	.23*	.15	.09
Elderly Woman Crying/Fire	.31***	.06	.34**	.3**	-.14
Sad Woman in Burnt House	.29***	.21	.25*	.17	.16
Amputee Boy	.28***	-.02	.53**	.07	-.05
Dying Man	.21***	.19	.26**	.17	.03
Grieving Woman	.17***	.22*	.18	.17	-.14

Note. N = 98-100 to account for missing data removed listwise. Supplemental Table S8 provides the original picture names to match the picture descriptions in this table. Pictures are ordered in descending order from largest to smallest adjusted R^2. β = standardised regression weights.

*p < .05; **p < .013 Bonferroni corrected (4 predictors); ***p < .001.

4.6.2.2 Do People's Appraisals of their Helping Potential Predict Motivational Direction in Sad Situations?. After adjusting for the number of fixed effects in the model, the model explained 63.6%. All three appraisal ratings (in descending order of beta weight), comfort (F(1, 1975) = 227.70, p < .001, β = .33), useful (F(1, 1932) = 101.52, p < .001, β =

.26), and welcome ($F(1, 1954) = 64.82$, $p < .001$, $\beta = .17$) significantly predicted motivational direction ratings at $p < .001$ level. Although valence significantly predicted motivational direction ratings at $p < .05$ level, ($F(1, 1905) = 4.30$, $p = .038$), the contribution of valence to the model was small ($\beta = .06$), therefore it signifies that the relationship between valence ratings and motivational direction responses is not meaningful for sad situations.

The random effects indicated that participant level significantly affected motivational direction response ($p < .001$), indicating that the variance from participants is significantly different from zero. The random effect of picture stimuli also had a significant effect on motivational direction responses ($p = .009$), indicating that there was variance among predictors across picture stimuli. Therefore, we ran individual multiple regression analyses on each of the 20 picture stimuli to assess the predictive power of the appraisals (useful, comfort, welcome, and valence) for each of the individual picture stimuli. The multiple regressions allowed for the examination of the predictive power of the appraisals and valence on motivational direction response at the picture stimulus level. Please also see Supplementary K for an additional analysis where we assessed the extent to which valence responses to sadness were predicted by the appraisals (useful, comfort, welcome).

4.6.2.3 Do Valence and the Appraisals that Predict Motivational Direction Vary Across Pictures?. Twenty multiple linear regressions were calculated to predict motivational direction responses based on our appraisals: usefulness providing help, level of comfort providing help, how welcome help would be, and valence. All 20 overall models were significant at the $p < .001$ level (which is less than the Bonferroni corrected value of .003). There was at least one significant predictor for all but one picture (‘Grieving Woman’), whereby all four predictors were non-significant at Bonferroni corrected ($p < .013$) level (see Table 4.3 for adjusted R^2 and Betas (β) for all four predictors across all 20 multiple

regressions)[8]. Overall, these results indicate that appraisals of helping potential predict motivational direction responses in sad situations, whereas overall, valence does not contribute to the model for all situations (except one, 'hospital'). Moreover, they demonstrate that the three appraisals had differing impacts on individual participants' responses, with some appraisals either in isolation (e.g., comfort alone for 'sad woman in burnt house') or in combination (e.g., comfort and useful for 'child in hospital') contributing as predictors of motivational direction responses. Overall, valence being a non-significant predictor for most sad situations shows that motivational direction and polarity of valence are treated differently by individuals, which suggests that unlike valence, motivational direction may be subject to an individual's appraisal of a situation, whereas a valence response is generally consistent (negative) for sad situations. This provides further support to Study 1's findings that motivational direction and polarity valence are independent constructs, and that there are instances where they do diverge, as this study demonstrates that the two constructs are understood differently and are the product of different mechanisms in some contexts.

4.7 General Discussion

Multiple theoretical models have been proposed to explain the effect of emotion on cognition. One influential class of models espouses that the valence of emotion (e.g., the broaden-and-build hypothesis; Fredrickson, 2001) determines cognition, whereas another model claims that motivational intensity or direction (e.g., the motivational dimension model of affect; Harmon-Jones, Gable, et al., 2012), rather than valence, is the driver of such effects. Our recent work has questioned whether motivation and valence are truly distinct from one another (Campbell et al., 2021). Here, we investigated this question more fully by testing discrete emotions that have been claimed to separate motivational direction from valence. Study 1 assessed the relationship between motivational direction and valence for five discrete

[8] For 'Grieving Woman', one predictor (useful) was significant at $p < .05$ level.

emotions (amusement, anger, awe, desire, and sadness). Initial analyses at the group level showed a statistical difference between motivational direction and valence ratings for sadness, anger, and amusement, but not for awe or desire. However, the totalled average difference scores for each discrete emotion that did differ across motivational direction and valence ratings did not change across polarity (e.g., for sad pictures both motivational direction and valence were negative in polarity (unpleasant and avoidance)). In addition, when the individual picture stimuli were assessed at the participant level the true extent of the differences between motivational direction and valence polarity were seen. Participants' motivational direction responses were more variable than their valence responses, specifically for sadness, anger, awe, and desire. For instance, all participants felt unpleasant valence (-) while viewing the 'People at a Car Crash' sad picture, but across a different participant group, on the same picture, there was large variance in responses on motivational direction (e.g., some wanted to avoid (-) and some wanted to approach (+); see Figure 4.3). These findings show that motivational direction and valence are not one and the same, as for these four discrete emotions there is significant divergence between them. What drives these substantial individual differences in motivational direction responses? Study 2 demonstrated that three helping-related appraisals (e.g., how useful participants thought their help would be) explained a significant amount of variance in participants' motivational direction responses to sad pictures. The implications of these results are discussed below.

4.7.1 Individual Differences in Motivational Direction Responses and the Influence on Cognitive Processing

Previous work that has investigated the link between emotion and approach/avoidance motivation has focused on how a stimulus that generates a particular emotion can elicit both approach and avoidance behaviours, under different conditions (Izard, 1992). For instance, animals will respond to a threatening situation by exhibiting fight (approach) or flight

(avoiding) response depending on factors like their capacity to respond to the threat or escape the situation (Panksepp, 2004; Panksepp, 2010). Other work in human infants has shown that anger may lead to approach-related tendencies (e.g., Lewis et al., 1990; Lewis et al., 1992). In contrast to this prior work, the present studies focus on the dimensional association between motivational direction and valence across a range of discrete emotions to uncover divergences. By using explicit ratings from human adults, we were able to directly demonstrate decoupling of valence from approach/avoidance responses between individuals.

The present results revealed that individuals differed markedly in their experience of motivational direction in response to the same picture. This is important because some previous studies that have concluded that motivational direction drives aspects of cognition (Gable et al., 2016) have assumed that a given stimulus (e.g., graveyards, people crying) evokes a specific motivational direction (e.g., approach motivation) in all or most participants (even if they differ in the magnitude of this approach motivation, i.e., low/high). However, the present results highlight that this assumption cannot be made with confidence, because the same picture can result in approach and avoidance motivation in different individuals. Such individual differences may not just dilute experimental effects, but could lead to effects being categorically mislabelled, and therefore inaccurate conclusions about the influence of approach versus avoidance motivation on cognition. For example, if it is assumed that a sadness-inducing stimulus results in approach motivation in most individuals, and thus the effect of a sadness induction on cognition is attributed to approach motivation, this could be incorrect if participants' appraisals led to avoidance motivation in most participants in the sample.

4.7.2 The Role of Appraisals

The variation observed in participants motivational direction responses was especially salient for sad situations, which is consistent with previous work that has made opposing predictions about sadness and its relationship with avoidance and approach motivation (Frijda,

1986; Gray et al., 2011; Lazarus, 1991; Nesse, 2006). That is, original appraisal theorists posit that discrete emotions can evoke different action tendencies (e.g., the urge to avoid or approach; Frijda, 1986; Lazarus, 1991). Although some people prefer to avoid situations that make them feel sad, for others, studies have shown that sadness may operate by motivating them to engage in prosocial behaviour (i.e., approach) (Gray et al., 2011). The tendency to approach in sad situations demonstrates the critical role of sadness displays in empathy (Cialdini et al., 1987; Fultz et al., 1988).

Considering our finding that appraisals of helping potential predict motivational direction responses to sad situations, an important follow-up would be to assess the types of appraisals that may be driving motivational direction responses in other discrete emotions (e.g., anger, awe, and desire). It is likely that motivational direction responses for other discrete emotions are driven by different sets of appraisals. For example, it is possible that if an individual feels angry while viewing a situation (e.g., witnessing a person engage in political ideologies they disagree with), the observer makes an appraisal of their safety risk (e.g., emotional) in the situation. If the observer feels that the safety risk is low (e.g., a political advocate who has extensive knowledge on the topic and feels they can comfortably defend their views), they may want to approach the situation that caused their anger to engage in confrontation (e.g., political debate) (e.g., Jung & Young, 2019).

4.7.3 Limitations

While our novel finding indicates that appraisals of helping potential predict motivational direction responses in sad situations, our methodology is limited to static pictures, self-reports, and university students. It is possible that pictures alone did not capture the full emotional and motivational experience. For example, can a static picture elicit the aggressive urge to approach that may be experienced for some when another person directly insults them? In future, other induction techniques (e.g., films, vignettes, recall, see Siedlecka & Denson,

2018) and additional features beyond pictures (e.g., expectancy to eat desserts and to act; Gable & Harmon-Jones, 2008a; Harmon-Jones et al., 2006) can be used to potentially evoke greater emotion and motivational experiences.

Other aspects of our methods also pose potential limitations. Self-reports may be impacted by participants' intention to respond in a socially desirable way (Holtgraves, 2004). Physiological measures could be used to overcome such extraneous variables. However, physiological measures would need to be validated against other measures of emotion and motivation (e.g., they must correspond with self-reports), which, to our awareness is not available for motivation in the current literature. We used population specific stimuli to represent the young-Australians experience (e.g., Australia's Broadcasting Company's TV show Kath and Kim). By using this Australian sample and targeted stimulus set, we may not have yielded generalizable claims about emotional and motivational experiences. Future research could use more diverse populations, while maintaining population-appropriate stimuli.

Another important consideration for the current studies is the large amount of individual variance in responses in Study 1 and 2 may indicate that participants in our picture selection pilot study (Supplementary A) experienced mixed discrete emotional experiences. For example, rather than experiencing anger alone, they may have experienced a mixture of sadness and anger. In Study 1 our aim was to select pictures that best represented each of the discrete emotions of interest, and our methods for choosing these pictures were based on previous studies that had classified pictures on discrete emotions (Briesemeister et al., 2011; Riegel et al., 2016). In future, researchers should consider individual differences across all rating scales and the impact of possible variance on their research topic.

4.7.4 Anger is Not (Always) Approach-Motivated

A large body of work has explored the mixed approach/avoidance responses that are likely evoked during anger (Carver & Harmon-Jones, 2009; Zinner et al., 2008). However, some studies have relied on the assumption that anger is approach motivated to make claims about the impact of motivational direction on cognitive processes (e.g., Harmon-Jones, 2007; Harmon-Jones & Gable, 2018; Harmon-Jones et al., 2006; Zinner et al., 2008). In contrast, our results, averaged across participants and for most individuals and stimuli, support the idea that anger is often avoidance motivated (Carver & Harmon-Jones, 2009; Frijda et al., 1989; Zinner et al., 2008). Our data highlight that research investigating approach-motivated anger needs to validate that their stimuli elicit approach, including in the individuals they sample. In our Study 1 the mean motivational direction rating for the anger pictures was -2.16 (on a scale from -4 (*avoid*) to +4 (*approach*)). In other words, the anger-inducing pictures were on average associated with strong *avoidance* motivation. There was small variation in responses across motivational direction, however, majority of responses were avoidance motivation (the greatest approach motivation count (any rating > 0) on one anger picture was 6 out of 30). This is consistent with the results of Kaczmarek et al. (2021), who also recently obtained evidence consistent with anger inducing avoidance motivation. It is also consistent with a study by Gable et al. (2016), where they did collect ratings of motivational direction following exposure to anger-inducing films in their Experiment 5. In their two conditions, participants provided ratings of 6.82 and 7.05 on a nine-point scale that ranged from 1 (*move towards*) to 9 (*move away*). This is indicative of avoidance motivation, because the means are closer to the avoidance anchor than the approach anchor of the scale. Thus, while Gable et al. (2016) did not interpret it this way, their results are consistent with ours and Kaczmarek et al. (2021) in suggesting that participants may be more likely to experience avoidance rather than approach motivation in response to anger-eliciting stimuli.

Indeed, one of the pieces of evidence claimed to support the notion that anger is approach-motivated is that trait Behavioural Activation Scores (BAS) scores correlate with trait anger (Harmon-Jones, 2003). However, because this evidence is correlational the direction of causality is uncertain. While it could be that anger promotes approach motivation, anger is typically thought of as the response to the blocking of obtaining an expected goal (Harmon-Jones & Allen, 1998). Thus, equally it could be that those prone to approach motivation are likely to experience more anger, in which case this association does not necessarily provide support for the notion that anger directly causes approach motivation.

4.7.5 Does Motivational Direction Offer Anything Above and Beyond Valence?

The present findings are consistent with the notion that, for at least some discrete emotions for some individuals, motivational direction is distinct from valence. It has been claimed that the utility of motivation is that it predicts changes in cognitive scope (broadening/narrowing) (Harmon-Jones, Price, et al., 2012). Considering that there are scenarios where they do diverge, it is important to consider the effects of motivation and valence on changes in cognitive scope. There are competing theories regarding what drives changes in cognitive scope, a valence-based one (Fredrickson, 2001; Fredrickson & Branigan, 2005) and a motivation-based one (Harmon-Jones, Price, et al., 2012). There is extensive research on both the effects of motivational intensity and valence on cognitive broadening/narrowing in isolation, high vs. low motivational intensity (e.g., Gable & Harmon-Jones, 2008a, 2010a), and positive vs. negative valence (e.g., Fredrickson & Branigan, 2005). However, such studies that have tested these models have often not controlled for the other potential variable (e.g., ensuring the two stimuli that are designed to elicit different motivational intensities do not also elicit different degrees of valence or different levels of arousal). Much of the work on valence was conducted prior to motivational intensity and direction being considered a candidate for determining cognitive processes and thus did not

control for it. However, the work on motivational intensity/direction has not matched conditions for their degree of valence. It is not sufficient to just consider the absolute polarity of valence (e.g., whether it is positive or negative valence), because otherwise conditions could differ in their degree of valence (e.g., disgust could be greater in negative valence than sadness), and this, rather than motivation, could determine cognitive outcomes. This lack of consideration for other potentially influential variables means that despite decades of research, it is still not possible to be confident about precisely what variable is driving the observed behavioural effects. To our knowledge, there is no study that has varied either factors concurrently to determine which factor, or whether an interaction of these factors, influences cognitive outcomes such as attentional breadth. Testing the concurrent impact of motivational intensity and valence's impact on cognitive processing is what is needed in future research. Ultimately, we believe that the utility of motivational intensity will depend on whether it can explain variance in cognitive or biological variables that is not already accounted for by valence and arousal.

4.7.6 Conclusions

Our previous work questioned the concept of motivational direction as being distinct from valence (Campbell et al., 2021). However, it did not explicitly test five critical discrete emotions that have been suggested to separate motivational direction and valence, and therefore this is what we did here. The current studies' results indicated that there was only a small albeit significant difference between motivational direction and valence for some of these discrete emotions (namely sadness, anger, and amusement), when examined at the group level. However, when examined at the individual participant level, we saw stark differences in people's responses. That is, there was large individual variance across motivational direction (approach/avoid), but small individual variance across valence (positive/negative), particularly for two of the discrete emotions where an overall divergence was observed (sadness and anger).

These findings indicate that motivational direction and valence do diverge for some key discrete emotions. However, they also call into question the assumption often made in the previous literature, that particular stimuli will elicit the same motivational drive in all or most participants. Instead, there are substantial individual differences, and thus any study investigating theories where motivational intensity or direction are important need to establish the motivational intensity and direction that the stimuli elicited in their participants. We also found that appraisals explained a substantial amount of variance in participants' motivational direction responses to sad pictures.

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Chapter 5: Understanding and Measuring Cognitive Scope

5.1 Chapter Rationale

Given that the previous chapters have provided core foundational knowledge about motivational intensity and how it converges with and diverges from arousal and valence, the fundamental question that motivated the work in this thesis can now be investigated. That is, which (if any) of the constructs, motivational intensity, arousal, or valence drives the broadening and narrowing of cognitive scope? Before this question is addressed empirically in Chapter 6, the current chapter will outline the foundations of cognitive scope, which includes discussing the various cognitive processes that fall under the umbrella of cognitive scope. The current chapter will also explain why the chosen representative of cognitive scope was attentional breadth, and why the chosen measure of attentional breadth in the empirical work conducted in Chapter 6 was the Navon task.

5.2 Understanding Cognitive Scope

Cognitive scope is defined as the broadening and narrowing of various cognitive domains and can be thought of in terms of cognitive 'expansion' (i.e., broadening) and 'retraction' (i.e., narrowing) (see, Gable & Dreisbach, 2021 for reviews; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013). Cognitive scope is an umbrella term that has been considered using a variety of cognitive processes, including memory (Gable & Harmon-Jones, 2010b; Threadgill & Gable, 2019b), time perception (for a review, see Gable et al., 2022), cognitive categorisation (Isen & Daubman, 1984; Price & Harmon-Jones, 2010), and attentional breadth (Derryberry & Tucker, 1994; Domachowska et al., 2016; Gable & Harmon-Jones, 2008a, 2010a; Hicks et al., 2012; Huttermann & Memmert, 2015; Nittono et al., 2012; Rowe et al., 2007; van Steenbergen et al., 2011; von Mühlenen et al., 2018).

The notion of broadening and narrowing of cognitive scope has a specific meaning in relation to each of these specific cognitive domains. In relation to memory, broadening and

narrowing has been used to refer to relative memory for stimuli in different spatial locations. For example, studies have suggested that a narrowing of memory is indicated by greater memory for centrally-presented targets, and that a broadening of memory is indicated by greater memory for peripherally-presented targets (Gable & Harmon-Jones, 2010b; Threadgill & Gable, 2019b). Time perception is also argued to broaden and narrow in its own way. Specifically, studies suggest that a hastening of perceived time represents a narrowing of time perception, and a lengthening of perceived time represents a broadening of time perception (e.g., Gable et al., 2016; Gable & Poole, 2012; Gupta, 2022; Rudd et al., 2012). In relation to cognitive categorisation, broadening and narrowing refers to how broadly versus narrowly participants define categories (Harmon-Jones et al., 2013; Isen & Daubman, 1984; Price & Harmon-Jones, 2010). That is, if participants define a word such as 'camel' as belonging to the category of 'vehicle', then the participant is said to have broader cognitive categorisation than if they do not consider the word 'camel' to belong to the category 'vehicle' (Isen & Daubman, 1984).

The broadening and narrowing of cognitive scope also extends to the attentional level (Harmon-Jones, Gable, et al., 2012), specifically, changes in attentional breadth. Here, attentional breadth is defined as the spatial extent over which attentional resources are allocated (Eriksen & St. James, 1986; Goodhew, 2020). There are functional advantages to the broadening and narrowing of attention in different contexts. Attentional resources can either be broadened to process more of a visual scene and to determine its 'gist' or summary statistics (e.g., to determine the direction that a crowd waves its hands in unison), or narrowed to facilitate higher resolution processing (e.g., to read fine text) (see Figure 5.1 for an example). Typically, on a task designed to measure attentional breadth, facilitation of participants target identification at the local (small letter) level relative to the global (large letter) level indicates a narrowing of attentional breadth, whereas facilitation of target identification at the global

level relative to the local level indicates a broadening of attentional breadth (e.g., Kimchi & Palmer, 1982; Navon, 1977).

Figure 5.1 *Example of Changes in Attentional Breadth*

a) **b)**

Note. An example of how an individual may change their attentional breadth in a real-life situation. (a) is an example of how a broadened attentional breadth may be used to interpret the direction that a group of people walk across a road. (b) is an example of how a narrowed attentional breadth may be used to locate a single individual from within a crowd walking across the road. The picture used here is from the Internet (https://unsplash.com/photos/IBaVuZsJJTo).

Empirical testing of competing theoretical models regarding the influence of emotion and motivational intensity on cognitive scope (e.g., the broaden-and-build theory of emotion, and the motivational intensity model of cognitive scope; Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a) have predominately focused on the effects of these variables on attentional breadth (e.g., Álvarez-San Millán et al., 2021; Derryberry & Tucker, 1994; Domachowska et al., 2016; Forster et al., 2006; Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a, 2010a, 2011b; Harmon-Jones & Gable, 2009; Harvey, 2016; Nittono et al., 2012; Rowe et al., 2007; Threadgill & Gable, 2019a; von Mühlenen et al., 2018). Therefore, if one is to adjudicate between these different accounts, then it makes sense to do so via attentional breadth. From a conceptual perspective, notions of broadening and narrowing of cognitive scope have clear intuitive meaning in relation to attentional breadth, which itself can be broadened or narrowed. In addition, attention is a process that can shape many other

downstream processes, including memory and time perception (Carrasco, 2011), and therefore attention represents a logical early-stage and influential cognitive process with which to gauge the effect of emotion and motivational intensity. Finally, from a practical perspective, there are well-validated tools with agreed-upon interpretations for measuring the narrowing versus broadening of attentional breadth. For these reasons, attentional breadth was chosen as the representative of cognitive scope for the empirical work carried out in Chapter 6.

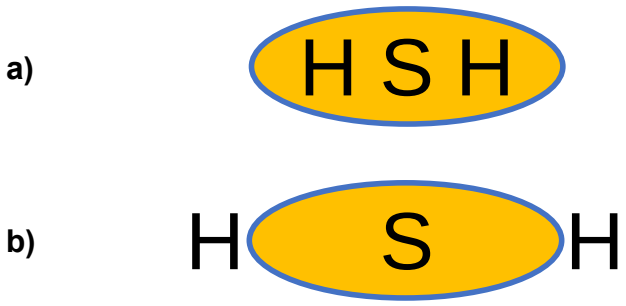
5.3 Methodology used for the Measurement of Attentional Breadth

5.3.1 The Flanker Task

Different ways that attentional breadth has been claimed to be measured will now be reviewed to determine which is likely to be the most valid methodology to measure attentional breadth. The Flanker task has been used as a measure of attentional breadth when examining the effects of emotion on attentional breadth modulation (e.g., Rowe et al., 2007). In the Flanker task participants are instructed to identify a target stimulus, which is 'flanked' by non-target-stimuli (see Figure 5.2). For instance, a target stimulus (in this case a letter 'S') appears in the centre of the screen, and participants' task is to indicate whether a 'S' or 'H' is presented. In this example, the non-target stimuli consist of two single letters appearing on either side of the target letter (left and right). The non-target stimuli are always the same form (e.g., letter), but on congruent trials, the non-target stimuli are identical to the target (e.g., S S S) whereas on incongruent trials the non-target stimuli are different from the target (e.g., H S H). A flanker effect is defined as slower (and/or less accurate) identification of the target on incongruent trials compared to congruent trials (Biggs & Gibson, 2018). Non-target stimuli may also appear at different separations (e.g., closer together or further away) from the target stimuli, to determine how the flanker effect varies across this spatial separation. Flanker effects typically diminish with increasing spatial separation between the target and non-targets (Eriksen & Eriksen, 1974). While the flanker effect has been used to gauge other cognitive processes too

(e.g., inhibition and executive attention), it has been used as a measure of attentional breadth predicated on the logic that only when flankers fall within a person's attentional breadth should they be processed and therefore produce a flanker effect. When flanker effects are diminished or eliminated at a given spatial separation in one condition, or in one participant relative to another, then this is inferred to reflect a narrower attentional breadth compared with a stronger flanker effect at the same spatial separation.

Figure 5.2 *Example Illustration of Two Incongruent Flanker Stimuli Sets at Different Separations*



Note. Both (a) and (b) are examples of incongruent flanker trials because the target letter 'S' is flanked by a different letter 'H' on each horizontal side. For a congruent flanker trial, the target letter (e.g., 'S') is flanked by the same letter (e.g., 'S') on each horizontal side. a) is a flanker trial at a closer target-flanker distance, and b) is a flanker trial at wider flanker-target distance. In this example, participants may be asked to identify the target letter 'S/H'. The blue-outlined yellow ovals highlight hypothetical attentional breadths. In a), the flankers fall within the attentional breadth, and therefore, would impact the participants identification of the target, producing a flanker effect. In b), the flankers fall outside the attentional breadth, and therefore would not impact the participants identification of the target, producing no or a minimal flanker effect. Therefore, the presence or absence of a flanker effect at a given spatial separation or determining how the flanker effect varies across distances between the target and flankers can provide a measure for changes in attentional breadth.

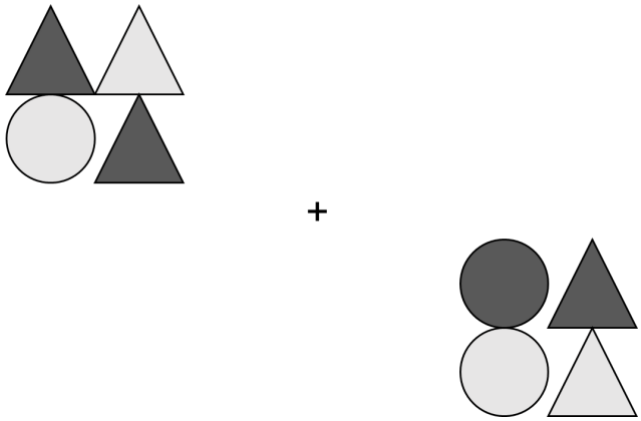
There are several issues with using the flanker task to operationalise attentional breadth. First, it may be unduly influenced by other non-breadth related processes, such as inhibition. For example, even if stimuli fall within a person's attentional breadth, they may be able to inhibit the information, and this could influence the magnitude of their flanker effect. Second,

the flanker task may manipulate attentional breadth, instead of measuring it, because the non-target flankers are not helpful for task completion and are actively unhelpful on some (usually 50%) of trials. Therefore, the optimal strategy to efficiently complete the flanker task is to narrow one's attentional breadth to exclude the flankers. Specifically, participants can narrow their attention to the central target (e.g., 'S'), ultimately ignoring the flankers (e.g., 'H') on each horizontal side. As such, task performance may reflects one's minimum attentional breadth (Goodhew, 2020). Indeed, the flanker task has in fact been used as a tool to focus participants attention during trials (Threadgill & Gable, 2019b). However, it is preferable to measure attentional breadth via a task that does not encourage or compel participants to consistently broaden or narrow their attentional breadth.

5.3.2 Breadth-of-Attention Task

The breadth-of-attention task includes the presentation of two groups of shapes, which appear at equal distance from the central fixation point. Participants are instructed to report details in both groups of shapes (see Figure 5.3). For example, in the single trial presented in Figure 5.3, two groups of four shapes are presented together at the same distance to the left and right of the central fixation point. In each group of shapes, there are circles and triangles that can be shaded light grey or dark grey. In a single-trial, participants are asked to make two responses: 1) identify the number of light grey triangles in the first group, and (2) identify the number of light grey triangles in the second group. The logic is that when participants can accurately report details from each of the groups consistently, when the shapes are positioned at a particular distance from fixation, this can be interpreted as a measure of attentional breadth (Hüttermann et al., 2012; Huttermann & Memmert, 2015; Hüttermann et al., 2014). In particular, the separation between the two groups of shapes at which participants can still achieve 75% accuracy is considered their breadth of visual attention (Hüttermann et al., 2014).

Figure 5.3 *Example Illustration of Breadth-of-Attention Task Stimuli Presented at a Right Diagonal Meridian*



Note. Stimuli are presented here at a right diagonal meridian. Stimuli can also be presented at different meridians (horizontal, diagonal, vertical). The distance from the central fixation point to the groups of shapes is varied throughout an experimental block to measure changes in attentional breadth. Here, participants may be asked to indicate how many light grey triangles are in each of the groups of shapes. They would first be asked to report the number of light grey triangles in one of the groups of shapes (e.g., group of shapes to the left), before reporting the number of light triangles in the other (e.g., group of shapes to the right).

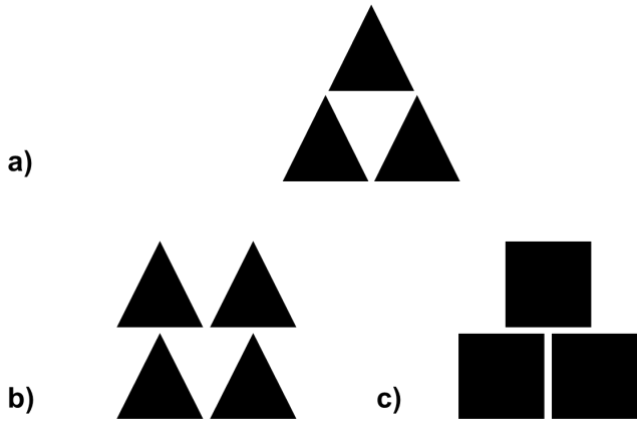
The breadth-of-attention task has been observed to successfully capture variance across different individuals, including those of different ages (Hüttermann et al., 2012), those with athletic expertise versus novices (Hüttermann et al., 2019; Hüttermann et al., 2014), and those experiencing different emotional and motivational states (Huttermann & Memmert, 2015). However, precisely what aspect of attention is required to complete the breath-of-attention task remains unclear. In other domains, visual search for a conjunction of features (e.g., colour and shape, as in light grey triangle amongst other light grey shapes and other triangles) is typically thought to compel participants to adopt a narrow attentional breadth that needs to be shifted around systematically to identify the target (Chong & Treisman, 2005). If so, then this would mean that participants would shift their attention between the two groups of shapes to complete the breadth-of-attention task, rather than expanding their attentional breadth to include both groups of shapes at the same time. Alternatively, there is evidence that people can split their attention into two discrete locations at the one time (Müller et al., 2003), and some participants

may be using this strategy to complete the task. Such adaptive regulation of attention is often limited to those with high working memory capacity (Bleckley et al., 2003), and indeed individuals with higher working memory capacity perform better on the breadth-of-attention task (Kreitz et al., 2015). Altogether, the breadth-of-attention is not an appropriate candidate measure because it most likely does not isolate the contraction and expansion of attentional breadth from a variety of other attentional processes.

5.3.3 The Hierarchical Shapes Task

The hierarchical shapes task has also been proposed to measure attentional breadth (Kimchi & Palmer, 1982) and has been used when examining the effect of emotion and motivation on attentional breadth (e.g., Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a; Tidikis et al., 2017; Yang et al., 2021). In this task, participants are presented with a standard shape (e.g., three small triangles combined to make one large triangle; see Figure 5.4a) and typically two comparison shapes, whereby each comparison shape matches the standard shape with respect to either the local elements (e.g., four small triangles combined to make one large square; see Figure 5.4b) or the global element (e.g., three small squares combined to make one large triangle; see Figure 5.4c). Participant's task is to report which of the two comparison shapes best represents the standard shape. The idea here is that when participants consistently select the shape that represents the local elements of the standard shape (e.g., Figure 5.4b) over several trials, this would indicate the participant has a narrow attentional breadth. In contrast, if the participant were to more consistently select the comparison shape that represents the global elements of the standard shape over several trials (e.g., Figure 5.4c), then this would indicate they have a broad attentional breadth. Attentional breadth size is determined by the participant's average response over several trials consisting of various stimulus sets (e.g., where the standard and comparison shapes change).

Figure 5.4 *Example Stimulus Set Used in the Hierarchical Shapes Task*



Note. a) is the standard shape and b) and c) are the comparison shapes. For a single trial, participants' task is to select the comparison shape that most accurately matches the standard shape. Participants may either select the comparison shape that represents the global make-up of the standard shape (c), or the comparison shape that represents the local make-up of the standard shape (b). In this way, which comparison shape the participant chooses (global or local make-up) is used as an operationalisation of attentional breadth.

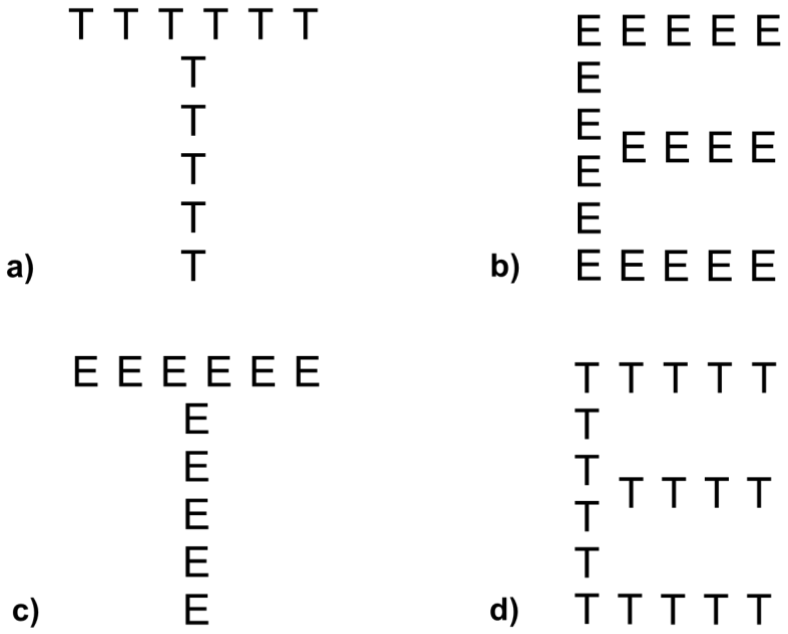
A potential issue with the hierarchical shapes task is that there is likely an upper limit on the number of trials for which participants can meaningfully report their subjective sense of which shape matches, and that this upper limit is likely much lower than that of a more standard performance-based task, such as identifying a target. Often, participants are asked to make assessments on a small number of stimulus sets (e.g., 1-8), and smaller number of stimulus sets means that the hierarchical shapes task may provide a relatively coarse measure of changes in attentional breadth (e.g., how many times the participant selects the global comparison shape out of 1-8 stimulus sets). However, even with a small number of stimulus sets, the hierarchical shapes task has been found to represent variance in different psychological processes (e.g., Basso et al., 1996; Dale & Arnell, 2015; Koldewyn et al., 2013). For example, just two trials of the hierarchical shapes task were sufficient to differentiate children with autism from neurotypical children (Koldewyn et al., 2013), and only 8 number of trials were needed to show associations with individual differences in trait mood tendencies (Basso et al., 1996).

The hierarchical shapes task has also been used effectively to measure changes in attentional breadth during emotional and motivational manipulations (Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a; Tidikis et al., 2017; Yang et al., 2021). Unlike the flanker task, the hierarchical shapes task does not compel participants to adopt a particular attentional breadth (e.g., broad, or narrow) and therefore can provide a sensitive measure of one's preferred or current attentional breadth. Further, unlike the breadth-of-attention task, the hierarchical shapes task more likely isolates a person's attentional breadth from other attentional processes. The hierarchical shapes task therefore represented a serious contender as the potential measure of attentional breadth for the empirical work carried out in Chapter 6. However, on balance the Navon task was chosen, because as described below, it has particularly compelling evidence for its validity, and did not have the potential limitation of being able to use only a small number of trials.

5.3.4 The Navon Task

In a single Navon stimulus, information is presented separately at both the global (large letter) and local (small letter) level (see Figure 5.5 for example global and local elements of Navon stimuli) (Navon, 1977). In attentional breadth research there are two versions of the Navon task that have been employed by researchers for use in different experimental situations, namely the 'directed Navon task' and the 'undirected Navon task' (the latter is also often called the 'divided attention Navon task', however this label makes unverified assumptions about how participants complete the task, and so the more neutral term of undirected Navon task is used here to refer to the fact that participants' attention is not directed to a specific level in the current version).

Figure 5.5 *Example Congruent (a, b) and Incongruent (c, d) Navon Stimuli*



Note. a) and b) represent two congruent Navon letters (Tt, Ee). The Navon stimuli are congruent because the global and local letters are the same. c) and d) represent two incongruent Navon letters (Te, Et). The Navon stimuli are incongruent because the global and local letters are different.

5.3.4.1 The Directed Navon Task. In the directed Navon task, participants are instructed to direct their attention to a particular level of the Navon stimuli. In one block, participants are told to only attend to the global (large letter) level of the Navon stimuli, and their task is to identify the letter at this global level. In another block, participants are told to only attend to the local (small letter) level of the Navon stimuli, and their task is to identify the letter at this local level. The extent to which conflicting information at the opposing level of the Navon stimuli is used to gauge attentional breadth. That is, in this version of the task, Navon stimuli are either congruent (same letter at the global and local level) or incongruent (different letter at the global local level). See Figure 5.5a and 5.5b for examples of congruent Navon stimuli, and Figure 5.5c and 5.5d for examples of incongruent Navon stimuli. If participants have fully and completely adopted the attentional breadth as instructed for that block, then the congruency manipulation for the content at the opposing level should not affect their responses.

For example, it has been shown that when participants are directed to the local level, they are slower to respond to targets when there is incongruent (vs. congruent) information at the task-irrelevant global level, whereas when participants are directed to the global level, congruency at the local level has no impact (Navon, 1981). This asymmetric pattern is often called a global precedence effect (Navon, 1981).

While the directed Navon task can provide insight into whether (and how successfully) participants can adopt a particular attentional breadth, it is not well-suited to providing a measure of a person's current attentional breadth. For this reason, while the directed Navon task was used historically, more modern work on attentional breadth typically used the undirected Navon task (Goodhew, 2020).

5.3.4.2 The Undirected Navon Task. In the undirected Navon task, participants are not told to attend to a specific Navon level (Goodhew, 2020; McKone et al., 2010). Rather, one of a set of pre-specified target letters appears on each trial, and it may appear at either the global (large letter) level or the local (small letter) level, and participants' task is to identify which target letter appeared. For example, participants may be asked to indicate whether the letter 'T' or 'H' appeared on that trial. In the undirected version of the task, the stimuli are always incongruent (i.e., always have different letters at the global and local level), and one (and only one) target is present in each stimulus (either at the global or local level). If target identification is faster for targets appearing at the global relative to the local level, then this is called a global advantage and indicates a broadened attentional breadth. However, if target identification is faster for targets appearing at the local level relative to the global level, then this is called a local advantage, and indicates a narrowed attentional breadth (Gable & Harmon-Jones, 2008a, 2010a; McKone et al., 2010). Most commonly this task is designed whereby the target appears equally (50% global/50% local) at either Navon level over a number of blocks of trials, and

whether the target appears at the global or local Navon level is intermixed throughout a single block.

There are a handful of different operationalisations of attentional breadth that have been claimed to be affected by emotion or motivational intensity. These include versions of the flanker task (Rowe et al., 2007), the breadth-of-attention task (Huttermann & Memmert, 2015), the hierarchical shapes task (Chan & Saunders, 2022; Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a), and the undirected Navon task (Dale & Arnell, 2010; Gable & Harmon-Jones, 2008a, 2010a, 2013; Harmon-Jones & Gable, 2009; Hicks et al., 2012). It is important to note that the operationalisation that has been used most often as the basis of such claims is the undirected Navon task. Therefore, to effectively measure changes in attentional breadth, the undirected Navon task was selected to operationalise attentional breadth in Chapter 6. The undirected Navon task does not have the limitations identified above that undermine the utility of the flanker task and the breadth-of-attention task as measures of attentional breadth. Crucially, moreover, there is clear evidence that attending to the global versus local aspects of Navon stimuli operationalises attentional breadth as intended. Specifically, Sasaki et al. (2001) showed that when participants attended to the global level of Navon stimuli, there was a larger spatial extent of activation in early visual brain regions than when attending to the local level of the same Navon stimuli. These findings are consistent with attending to the global level broadening attention. Moreover, the magnitude of the activation was weaker in the global versus local Navon stimuli condition, consistent with the influential zoom-lens model of attentional breadth, which espouses a trade-off between the spatial extent of attentional breadth and the magnitude of perceptual enhancement within it (Eriksen & St. James, 1986). Accordingly, Navon stimuli are unique amongst the motley different ways of measuring the consequences of emotion for attentional breadth to have this compelling evidence for their

validity. Therefore, for these reasons, the undirected Navon task was chosen as the measure of attentional breadth for the empirical study in Chapter 6.

Chapter 6: The Influence of Emotion and Motivation on Attentional Breadth: Does Motivational Intensity Offer Anything Above and Beyond Valence?

There are various theoretical models that claim that components of emotion or motivation drive the broadening and narrowing of cognitive scope. The broadening and narrowing of cognitive scope can be thought of as the 'expansion' and 'restriction' respectively of various cognitive domains, including cognitive categorisation (Price & Harmon-Jones, 2010), memory (Gable & Harmon-Jones, 2010b; Threadgill & Gable, 2019b), distance perception (Balcetis, 2016; Kawakami et al., 2007), time perception (Gable et al., 2016; Gable & Poole, 2012; Gupta, 2022), attentional flexibility (Calcott & Berkman, 2014; Ma & Li, 2016), and attentional breadth (Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a, 2010a, 2011a; Rowe et al., 2007). The competing theoretical models, however, contradict each other, as they each assert that a different emotional or motivational component—arousal, valence, or motivational intensity—is responsible for altering cognitive scope. In the present study, two of these models were pitted against each other to determine whether motivational intensity or valence might be the true driver of cognitive broadening and narrowing. Further, recent work has revealed marked individual differences in the direction of motivation (avoidance/approach) in response to the same stimulus (Campbell et al., 2022). Therefore, we also sought to test whether emotional and motivational effects on cognitive scope may ultimately be driven by variation at the individual level, rather than at the stimulus level. The following sections describe the competing emotion and motivation-based theoretical models.

6.1 The Roots of Emotion, Motivation, and Cognitive Scope

6.1.1 An Arousal-based Model: Easterbrook (1959)

The earliest theoretical account suggested that arousal is responsible for changes to cognitive scope (Easterbrook, 1959). Arousal refers to one's emotional experience ranging from low (e.g., calm) to high (e.g., excited/agitated) (Bradley & Lang, 2007a), which can be

measured physiologically by activation of the sympathetic nervous system. The arousal-based model posits that highly arousing affective-states narrow cognitive scope (Easterbrook, 1959). The original model focuses in particular on attentional breadth, which refers to whether spatial attention is focussed over a region that is narrow or broad (Eriksen & St. James, 1986; Goodhew, 2020). For example, the arousal-based model posits that fear is a highly arousing state, which typically makes individuals feel agitated, and can be coupled with activation of the sympathetic nervous system (e.g., increased heart rate). The model proposes that when fear is experienced (e.g., when we see a snake), our arousal levels are heightened, and hence, our attentional resources should narrow towards the stimulus that evokes the highly arousing response (e.g., the frightening snake). Narrowing during high arousal may stem from evolutionary functions, which aid in preparing individuals to engage in 'fight' or 'flight', and enables them to have heightened awareness of threatening stimuli around them (Panksepp, 2010).

The arousal-based model makes clear predictions about how arousal relates to cognitive scope. While Easterbrook (1959) refers to specific negative affective states (e.g., threat, anxiety) to demonstrate when a narrowing of cognitive scope may occur, the model is described in terms of arousal, rather than valence affecting cognitive scope. Overall, the model says little about other components of emotion and motivation, such as valence or motivational intensity, and their relative influence on cognitive scope.

6.1.2 A Valence-based Model: The Broaden-and-build Theory of Positive Emotions

Later work has suggested that it is not arousal, but rather, valence (Russell, 1980), our subjective experience ranging from negative (unpleasant) to positive (pleasant), that primarily drives the broadening and narrowing of cognitive and attentional scope (e.g., Basso et al., 1996; Fredrickson, 2001; Fredrickson & Branigan, 2005; Huttermann & Memmert, 2015; Johnson et al., 2010; Rowe et al., 2007). Fredrickson formulated one of the most influential valence-based

models in the field to date, the broaden-and-build theory (Fredrickson, 1998, 2001; Fredrickson & Branigan, 2005). One of the fundamental hypotheses of this model is that positive-valenced states (e.g., joy, interest, contentment, pride, and love) broaden attentional breadth relative to neutral ones. Most of the empirical work involving the broaden-and-build theory has assessed the effect of positively and negatively-valenced states on attentional breadth (Fredrickson & Branigan, 2005). The theory also hypothesises that positively-valenced states broaden 'thought action repertoires', which facilitates individuals in building personal resources and with engaging in a 'broader' assortment of thoughts and actions than they normally would (Fredrickson, 1998, 2001). For example, the theory predicts that when an individual feels contentment and joy (positive-valenced states), their mindset broadens, leading them to become more open to building personal resources (e.g., intellectual, social, physical, and psychological), which in turn, enables them to form new social connections and coping strategies that they can store for later use (Fredrickson, 2001).

The broaden-and-build theory also predicts that specific negatively-valenced states (e.g., anger, fear, anxiety) narrow attentional breadth and thought action repertoires to help prepare individuals to act decisively in potentially life-threatening situations (e.g., fight, flight) (Fredrickson & Branigan, 2005). The theory espouses that arousal does not affect the broadening and narrowing of cognitive scope (Fredrickson, 1998).

6.1.2 A Motivation-based Model: The Motivational Intensity Model of Cognitive Scope

Recently, the motivational intensity model of cognitive scope has claimed that it is neither arousal nor valence that is responsible for cognitive broadening/narrowing, but rather, motivational intensity, which is the strength of one's tendency to approach or avoid (Gable & Harmon-Jones, 2008a; Harmon-Jones, Gable, et al., 2012). Specifically, the model posits that states that evoke low motivational intensity broaden cognitive scope, and states that are high in motivational intensity narrow it (Gable & Harmon-Jones, 2010d).

The motivational intensity model of cognitive scope posits that both negative and positive-valenced states can vary in their motivational intensity (low/high). For example, fear and sadness are both negatively-valenced, however fear is said to have higher motivational intensity than sadness, because fear may elicit a stronger tendency to act than sadness (Gable & Harmon-Jones, 2010a). Thus, the model proposes that fear would lead to a narrowing of cognition due to its high motivational intensity, and sadness would lead to a broadening of cognition due to its low motivational intensity (Gable & Harmon-Jones, 2010a). The model also espouses that states that differ in valence may evoke the same motivational intensity, and hence have the same effect on cognitive scope. For example, fear and desire differ in their valence (negative/positive, respectively) but are said to be both high in motivational intensity, because they both may elicit a strong tendency to act. Therefore, the model would predict that fear and desire lead to a narrowing of cognition because of their high motivational intensity (Gable & Harmon-Jones, 2008a, 2010a). The functional logic for the narrowing of attentional breadth under high motivational intensity is that it facilitates 'zeroing in' on the motivationally-relevant stimuli (e.g., feared or desired object).

Another important element of the motivational intensity model of cognitive scope is that motivational intensity is argued to exist in two motivational directions: tendency to avoid (avoidance motivation) and tendency to approach (approach motivation), and both motivational directions can range from low-high in motivational intensities (for reviews, see Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012). It has been suggested that affective states may differ in their motivational direction (e.g., approach/avoid), but may share the same motivational intensity (e.g., high) (Gable & Harmon-Jones, 2008a, 2010a). For example, fear and desire are said to differ in motivational direction (avoidance/approach, respectively), but to both elicit high motivational intensity (Gable & Harmon-Jones, 2008a, 2010a).

The distinction between motivational intensity and motivational direction is important because the motivational intensity model of cognitive scope claims that the intensity of emotion is important for changes in cognitive scope (Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013), whereas models concerning other cognitive processes (e.g., time perception and asymmetrical cortical activation) (Gable et al., 2016; Gable & Poole, 2012) (Harmon-Jones & Gable, 2018; Harmon-Jones et al., 2010) assert that the direction of motivation is responsible for relative changes observed during these processes. Empirical work has typically considered either the intensity or the direction of motivation, and it is not always articulated why the specific motivation direction is important in some contexts but only overall intensity in others (e.g., Domachowska et al., 2016; Gable & Harmon-Jones, 2008a, 2010a; Gable & Poole, 2012; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Harmon-Jones et al., 2006; Harmon-Jones, Price, et al., 2012; Ma & Li, 2016; Threadgill & Gable, 2019b; Yang et al., 2021).

The model states that motivational intensity and arousal are closely related, but distinct (Gable & Harmon-Jones, 2008a, 2013). According to the model, for most affective states, changes in arousal may represent those in motivational intensity (e.g., low arousal = low motivational intensity; Gable & Harmon-Jones, 2008a; Harmon-Jones et al., 2011b). However, the motivational intensity model of cognitive scope posits that they are dissociable constructs as there are specific instances where they diverge. For example, the model suggests that during amusement, low motivational intensity is evoked, despite its high arousal level (Gable & Harmon-Jones, 2008a). Consequently, the model postulates that any previous broadening of cognitive or attentional resources observed during amusement (e.g., Fredrickson & Branigan, 2005) should be attributed to the low motivational intensity that amusement evokes (Gable & Harmon-Jones, 2008a). In relation to previous arousal-based theories, the motivational intensity model of cognitive scope predicts that any narrowing of cognition previously

suggested to occur during highly arousing states (Easterbrook, 1959), may be due to the simultaneously evoked high motivational intensity (e.g., that experienced during fear) (Gable & Harmon-Jones, 2013).

Regarding motivational intensity's proposed relationship with valence, the motivational intensity model of cognitive scope suggests that motivational intensity is distinct from valence (Gable & Harmon-Jones, 2010d). Specifically, the model proposes that affective states that are negative can be approach motivated (e.g., anger; Gable et al., 2015), and affective states that are positive can be avoidance motivated (Gable & Harmon-Jones, 2008a). The model also suggests that motivational intensity (low/high) can vary within positive and negative-valenced states (Gable & Harmon-Jones, 2010d). For example, the model argues that any previous broadening observed during positive-valenced states (e.g., Fredrickson & Branigan, 2005) was likely due to the low motivational intensity evoked during those manipulations (Gable & Harmon-Jones, 2008a). The model suggests it is likely that previous valence-based models (broaden-and-build theory) did not explore positive-valenced states that were high in motivational intensity, and that is why no narrowing of cognition was observed during their manipulations of positive-valenced states.

6.2 Motivational Intensity is (Somewhat) Distinct from Valence

A fundamental issue is that when the motivational intensity model of cognitive scope was proposed, the relationship between motivational intensity and valence and arousal was not tested. Rather, the model claimed that motivational intensity is distinct from arousal (Gable & Harmon-Jones, 2013) and valence (Carver & Harmon-Jones, 2009), without empirically testing this claim. Further, empirical tests claimed to assess the influence of motivational intensity on cognitive scope have (a) often failed to validate that motivational intensity has in fact been successfully manipulated, and/or (b) failed to control for either valence or arousal (e.g., Gable & Harmon-Jones, 2008b; Gable et al., 2016). This means that both valence and arousal remain

viable candidate drivers for all of the effects attributed to motivational intensity. For example, previous studies have relied on assumptions regarding how discrete emotions relate to motivational levels (e.g., strong desire represents strong approach motivation; Gable & Harmon-Jones, 2008a, 2008b; Harmon-Jones & Gable, 2009), despite never testing this assumption, or studies have used arousal as a proxy for motivational intensity (e.g., strong arousal represents strong motivational intensity; Gable & Harmon-Jones, 2010c), despite never establishing the relationship between motivational intensity and arousal. Further, some studies have demonstrated differences in participants' valence and arousal ratings between conditions claimed to reflect different motivational intensities, but then attributed the behavioural differences to unmeasured motivational intensity (e.g., Gable & Harmon-Jones, 2010a; Threadgill & Gable, 2019b).

In a recent collection of studies (Campbell et al., 2021, 2022), this much needed empirical work was completed. The first study aimed to compare the dimensional aspects of motivation, against valence, and arousal. In the initial work, subjective ratings of motivational intensity, valence, and arousal were collected in response to a diverse range of pictures, and the ratings were compared to determine if motivational intensity is distinct from, or the same as valence or arousal (Campbell et al., 2021). Findings revealed a modest relationship between motivational intensity and arousal, which indicated that arousal is not an appropriate proxy for motivational intensity. Campbell et al. (2021) also found a very high degree of correspondence between motivational intensity and valence, to the extent that it was questioned whether they are dissociable (Campbell et al., 2021). More recently, however, we found that there were divergences between motivational intensity and valence ratings when we sought to evoke specific discrete emotions (specifically, sadness, anger, and amusement) (Campbell et al., 2022). Other recent research has also suggested similar divergences (Kaczmarek et al., 2021). Therefore, in the present study we sought to determine which (if any) of motivational intensity

or valence drives cognitive broadening and narrowing, under conditions where these two dimensions were directly measured and considered.

6.3 Considering the Influence of Individual Differences in Emotion and Motivation on Cognitive Processing

In our recent work examining the relationship between motivational intensity and valence across a specific set of discrete emotions, we also found that there were large individual differences across the direction of motivation (approach/avoid) during some discrete emotions (sadness, anger, awe, and desire) (Campbell et al., 2022). For sadness, while viewing the same sad situation (e.g., a crying child) some individuals wanted to approach, and others wanted to avoid. It is possible that previous studies (e.g., Gable & Harmon-Jones, 2010a) that assumed a stimulus elicited the same motivational direction (e.g., approach) for all participants may have categorically mislabelled the motivation responsible for the effect. For example, if the researchers assumed that a particular stimulus elicits an approach motivation, but more than half of participants in the sample experienced avoidance motivation in response to the stimulus, then the average behavioural effects could reflect avoidance motivation, but they may be misattributed to approach motivation. Relying on the assumption that a stimulus elicits the same motivational direction in most participants is particularly problematic in light of models that ascribe different cognitive consequences to approach versus avoidance motivation (Gable et al., 2016; Gable & Poole, 2012). Therefore, it is important to consider individual participants' motivation in response to stimuli, rather than assuming that a particular stimulus elicits a given motivational response for all participants. While previous work has considered individual differences in the extent of approach or avoidance motivation (e.g., whether increasing time since eaten enhances what is assumed to be approach motivation to desserts; Gable & Harmon-Jones, 2008a), Campbell et al. (2022) demonstrated individual differences that differed in polarity from approach to avoid, that is, qualitative rather than merely

quantitative differences across individuals, which has not been captured in previous work. Here, in the present work we also considered such differences.

6.4 The Present Work

A review of the literature indicates that research has typically focussed on two primary contenders for the main driver of cognitive broadening and narrowing. One is a valence-based model (e.g., Fredrickson, 2001; Fredrickson & Branigan, 2005; Johnson et al., 2010) and the other is a motivation-based model (e.g., Gable & Harmon-Jones, 2008a, 2010a; Gable & Poole, 2012; Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012; Hicks et al., 2012; Ma & Li, 2016; Threadgill & Gable, 2019b; Yang et al., 2021). The valence-based model proposes that all negative valence affective states narrow cognitive scope, and all positive valence affective states broaden it (Derryberry & Tucker, 1994; Fredrickson, 1998, 2001; Fredrickson & Branigan, 2005), while the motivational intensity model of cognitive scope proposes that irrespective of valence, all affective states high in motivational intensity narrow cognitive scope, and those low in motivational intensity broaden it (for reviews, see Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013; Harmon-Jones, Price, et al., 2012) (see Figure 6.1 for a schematic illustration of the two models underlying components of emotion and motivation). To our awareness, there is limited to no empirical work that directly compares the effects of the two influential models on cognitive broadening and narrowing. Instead, the majority of the valence-based work was conducted prior to the motivational intensity model of cognitive scope and thus did not consider it, and the empirical work on motivational intensity has failed to match stimuli claimed to differ in their motivational intensity on their degree of valence, and even used significant differences in valence ratings between conditions as a manipulation check for changes in motivational intensity (e.g., Gable & Harmon-Jones, 2010a). Therefore, there is the clear need for work that differentiates these two candidates to determine which actually drives cognitive scope, and this is what we sought to do here.

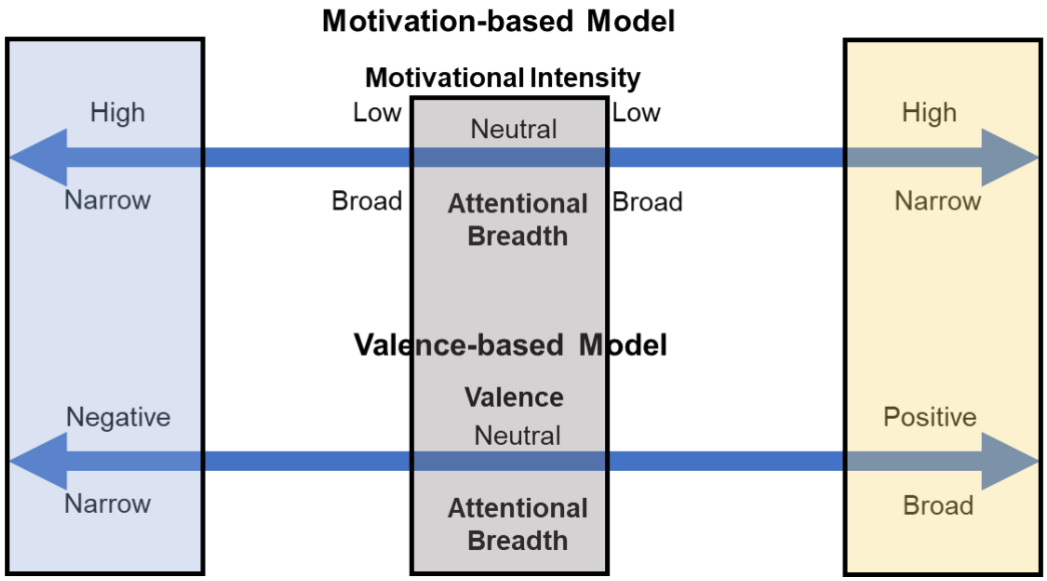
Historically, an arousal-based model has also been proposed as a driver of cognitive broadening and narrowing (Easterbrook, 1959). However, limited empirical work has been conducted to assess arousal's influence on cognitive broadening and narrowing. In some empirical work that has been conducted, arousal is used as a proxy for motivational intensity (Gable & Harmon-Jones, 2010a, 2010d; Harmon-Jones & Gable, 2008; Harmon-Jones, Gable, et al., 2012; Harmon-Jones, Price, et al., 2012). While arousal may have not received the same attention, it does remain another viable candidate driver of cognitive scope. However, since motivational intensity and valence are currently centre stage in theoretical debate, we reasoned that a logical starting point was to focus on differentiating these two aspects of emotion. Therefore, arousal may need to be considered in future research, or some potential pattern of results may render arousal unviable as a driver of cognitive scope. For example, if we find that positive valence broadens attention while negative valence narrows it, then this differential pattern across different valences would mean that arousal cannot be the determinant of cognitive scope.

The current work will also consider the influence of individual differences in emotional and motivational experiences on changes in cognitive scope. A handful of previous studies have explored individual differences within motivational directions (e.g., exploring isolated changes within approach motivation or avoidance motivation; Gable & Harmon-Jones, 2008b; Harmon-Jones, 2007; Harmon-Jones et al., 2006; Threadgill & Gable, 2019a; Zinner et al., 2008). Here, however, consistent with Campbell et al. (2022), we will consider possible changes in the polarity of motivational direction. Specifically, we will have each participant report the valence and motivational direction they experience in response to stimuli, rather than assuming a particular motivational or emotional response.

The inclusion of conditions for which the two models make qualitatively predictions represents a particularly strong test of the two competing models. Therefore, we selected one

set of stimuli intended to evoke positive valence and high motivational intensity (hereafter, 'positive-high'), for which the valence-based model predicts broadening of attention while the motivational intensity-based model predicts narrowing of attention relative to neutral baseline. We also selected another set of stimuli intended to evoke negative valence and high motivational intensity (hereafter, 'negative-high') for which both models make the same prediction (i.e., narrowing relative to neutral), to confirm that these predicts were supported. We also included a baseline (neutral) affective-prime condition (hereafter, 'neutral-low') so that relative changes to the broadening and narrowing of cognitive scope could be examined. However, rather than assuming these stimuli had the characteristics for which we selected them based on previous ratings, we had each participant rate the valence and motivational intensity that each stimulus induced for them.

Figure 6.1 *Schematic Illustration of the Two Opposing Models and the Three Affective-prime Conditions Selected for Experiment 1*



Note. The yellow shaded box on the right indicates the 'positive-high' condition, where the motivation-based and valence-based models have opposing predictions. The blue shaded box on the left indicates the 'negative-high' condition, where the motivation-based and valence-based models share predictions. The grey shaded box in the centre indicates the 'neutral-low' condition, which is used as a relative measure of changes in emotion, motivation, and attentional breadth.

We chose attentional breadth, here defined as the spatial extent over which attentional resources are allocated (Goodhew, 2020) as the representative for changes in cognitive scope. Attentional breadth is the most widely understood and studied facet of cognitive scope in this space (e.g., Derryberry & Tucker, 1994; Domachowska et al., 2016; Finucane, 2011; Finucane & Power, 2010; Forster et al., 2006; Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a, 2010a, 2010c, 2011a, 2011b, 2013; Goodhew & Edwards, 2022; Hicks et al., 2012; Huntsinger, 2012, 2013; Lacey et al., 2021; van Steenbergen et al., 2011; von Mühlenen et al., 2018; Yang et al., 2021). Please see Chapter 5 for a detailed outline of the other cognitive processes that fall under the umbrella of cognitive scope, and why attentional breadth was selected as the representative. Please also see Chapter 5 for a detailed analyses of the advantages and disadvantages of each of the attentional breadth measures, and for the rationale for choosing the Navon task as the measure of attentional breadth for the current study.

6.5 Method

6.5.1 Participants

We ran a priori-power analysis based on findings from a previous study that used a similar experimental design (Gable et al., 2015, Study 1) (https://designingexperiments.shinyapps.io/BUCSS_ss_power_wa/). Using the previous study's *F*-value ($F = 8.65$) and sample size ($N = 49$) with an interaction as the effect of interest for a 3 x 2 within-subjects ANOVA, we required $N = 58$ to achieve a power of .8 ($\alpha = .05$, two-tailed, assurance = .8). To factor in up to 10% for potential exclusions, we recruited 64 participants for Experiment 1. Participants were recruited from the Australian National University's SONA recruitment system or via word-of-mouth, and were offered course credit or cash as compensation. One participant was excluded because they were less than 80% accurate on at least one condition (e.g., negative-high local) on the affective-prime Navon task. The final participant sample size was $N = 63$.

Sixty-three participants (20 men; 43 women; M_{age} = 22.97 years, SD_{age} = 4.27; $range_{age}$: 18-39) met recruitment criteria and provided informed consent. Fifty-five participants identified as right-handed, 5 as left-handed, and 3 as ambidextrous. All participants were between the ages of 18 and 40, born and raised in a Western country, had English as their first language, had normal or corrected-to-normal vision, and had no indicated diagnosis of ADD/ADHD, Asperger's Disorder or any Autism Spectrum Disorder's, Schizophrenia, or any major neurological illness (e.g., Parkinson's disease, stroke, major head injury requiring hospitalisation). All participants gave voluntary, informed consent and all ethical aspects of this study were approved by the ANU Research Ethics Committee (Protocol 2019/182).

6.5.2 Stimuli and Apparatus

Pictures were used to induce affective states. In total, we used 72 coloured picture stimuli (24 pictures per affective-prime condition, i.e., for each of positive-high, negative-high, and neutral-low). Pictures were selected based on their motivational intensity (ABS) and valence ratings collected by Campbell et al. (2021), which were originally selected from the International Affective Picture System (IAPS) or the Internet.[9] We used the absolute value for motivational intensity (ABS) because the motivational intensity model of cognitive scope emphasises that it is the strength of motivational tendencies that drive attentional broadening and narrowing, and the model does not make assumptions about the direction of motivation (approach/avoid). Therefore, for the present study, we made it a priority that pictures evoked low or high motivational intensity, irrespective of their motivational direction. Additional pictures that did not appear in Campbell et al. (2021) were selected from the IAPS either based

[9] The following IAPS pictures were used: negative-high (1050, 1300, 2811, 3000, 3001, 3060, 3064, 3068, 3103, 6560, 7380, 8485, 9187, 9291, 9302, 9325, 9342, 9410, 9413, 9570, 9571, 9600, 9635.1, 9904), neutral-low (1419, 2104, 2190, 2214, 2493, 2880, 2890, 5120, 7004, 7010, 7014, 7026, 7050, 7056, 7059, 7060, 7090, 7150, 7175, 7233, 7234, 7255, 7950), and positive-high (1410, 1440, 1460, 1710, 1750, 1920, 2332, 5825, 5829, 5833). The following Campbell et al. (2021) pictures were used: neutral-low (funny_1), and positive-high (cat_02, cat_04, cat_06, cat_08, cat_12, delicious_1, delicious_4, delicious_5, delicious_8, funny_12, funny_3, funny_4, funny_7, funny_9).

on their normative valence and arousal ratings, or because they appropriately matched a picture in the respective affective-prime condition. The stimuli selected directly from the IAPS were not pre-selected on motivational intensity ratings, but we determined that their motivational intensity levels could be confirmed via ratings collected during the experiment. Only landscape pictures were used, and each picture within each affective-prime condition was matched with a picture from another affective-prime condition (e.g., negative_01 and positive_01 were matched as a pair) for animate/inanimate content and whether there were single/multiple objects to minimise the possible impact of these confounding variables on changes in attentional breadth (Nah et al., 2018). Whether the corresponding neutral-low condition picture (e.g., neutral_01) matched on animacy was less of a concern, and we prioritised matching for number of objects rather than animacy for the neutral-low pictures. Please see Chapter 6 Appendix A for names of pictures across the conditions that were considered a match. Pictures were presented at 10.95° (high) by 5.25° (wide) on a white background. This size was based on a previous study that demonstrated the effect of emotionally-salient pictures on temporal attention at this size (Proud et al., 2020).

To measure attentional breadth, we used hierarchical Navon stimuli in the undirected Navon paradigm. The choice to use the undirected Navon task was made for several reasons. First, in previous studies, the undirected Navon task is the most widely used measure of modulations in attentional breadth during emotion and motivation manipulations (Domachowska et al., 2016; Gable & Harmon-Jones, 2008a, 2010a, 2010c, 2011a, 2011b, 2013; Harmon-Jones & Gable, 2009; Hicks et al., 2012). Second, unlike many purported measures of attentional breadth, there is clear neuroimaging evidence to support the validity of attentional breadth measurement using Navon stimuli, such that when participants' attention is focussed on the local elements they have a narrower attentional breadth than when their attention is focussed on the global elements (Sasaki et al., 2001).

In the undirected Navon task, Navon stimuli are single large global element letters (e.g., H) made up of multiple small local element letters (e.g., E's) (see Figure 6.2). The global and local letters are always different from one another. The target letter (e.g., T or H) can either appear at the global (large letter) or the local (small letter) Navon level in any given trial, and participants' task is to identify which target letter (e.g., T or H) is present in each trial as quickly and accurately as possible. Only a single target (e.g., T or H) will appear in a single trial. The presentation of targets at the global or local Navon level are intermixed throughout a single block, and this intermixing of global and local trials is why the task has been called 'undirected' because participants are not instructed or directed to attend to a particular level, unlike the other major version of the Navon task (e.g., the directed Navon, also called the selective attention paradigm) (Goodhew, 2020). (The undirected Navon is also sometimes called 'divided attention' paradigm, but this term makes an untested assumption about how attention is allocated, and hence why the term undirected is used here instead). In the undirected Navon, faster global level (large letter) relative to the local level (small letter) target identification reaction time (RT) is thought to indicate a broader attentional breadth. Similarly, a faster local level (small letter) relative to the global level (large letter) RT indicates a narrower attentional breadth. The relative difference across local and global Navon level RT (local minus (-) global RT) can also be used as an index of attentional breadth changes and can be compared across baseline and experimental conditions to assess relative changes in attentional breadth.

For the Navon stimuli in the present study, the target letters were 'T' and 'H', which could appear at either the local or global level (50% each level, randomly intermixed). Non-target letters were 'E' and 'F', resulting in eight possible stimuli (Eh, Fh, Et, Ft, He, Hf, Te, Tf; where capital letter represents global letter and lowercase letter represents local letter). Large letters were presented at 4° by 4° while smaller letters subtended 1° by 1°. The Navon

stimuli were always presented in the centre of the screen and were black letters on a white background.

For the affective-prime and Navon task, all stimuli were presented on a PC monitor, with a resolution of 1920 x 1080 pixels and a refresh rate of 75Hz (via MATLAB's Psychophysics Toolbox). Participants were seated and a chinrest was used for the duration of the experiment to maintain a viewing distance of 60 cm. The pictures for the rating task were presented on the same monitor at the same viewing distance and the pictures were presented at the same size as the affective-primes. Furthermore, in the rating task, pictures and rating scales were presented on the screen together to ensure that participants were able to rate the pictures without having to scroll.

6.5.3 Design and Procedure

Participants completed the study in-person within a laboratory at the Research School of Psychology, the Australian National University (ANU). The experiment took approximately 45 minutes to complete. After the participant provided informed consent, the experiment commenced with the affective-prime and Navon task. For each trial, participants were instructed to focus their attention on the centre of the screen where the affective-prime was presented for 1000 ms, followed by a blank interstimulus interval (ISI) of 100 ms, and then a Navon stimulus was presented until response (see Figure 6.2). Participants' task was to identify the target letter 'T' or 'H' as quickly and accurately as possible by using their left and right hands to press the 'Z' and '?/' keys, respectively. There was a blank intertrial interval (ITI) for 1000ms between trials.

Previous studies have ranged in their affective-prime presentation times when looking at their influence of affective-primes on modulations of attentional breadth from shorter: 500 ms (Yang et al., 2021) or 750 ms (Calcott & Berkman, 2014) to longer presentation times: 3000 ms (Threadgill & Gable, 2019a) or 6000 ms (Gable & Harmon-Jones, 2010a). We sought to

select a duration that was long enough to ensure that the affective-prime elicited an emotional response, and to ensure that there was time for attentional breadth to be resized (due to the affective-prime) by the time we measured it via the Navon stimulus, but not so long that such effects may be waning or changing (e.g., resizing again) by the time of measurement. Given the event-related potential (ERP) evidence that emotional processes peaks at around 400-700ms (Bradley et al., 2007), and that attentional breadth resizing takes on average 100-150ms, but up to 500ms for some individuals (Goodhew & Plummer, 2019), we selected a picture presentation time of 1000ms and a 100ms ISI (Codispoti et al., 2007; Goodhew & Plummer, 2019). See Figure 6.2 for a schematic of a single trial used in Experiment 1.

Following instruction, participants completed six practice trials (three local, three global Navon target) with onscreen feedback about the accuracy of their response. Neutral affective-primes were used in the practice block (but were different pictures to those used in the experiment proper). Participants were required to successfully identify at least 5 of the 6 Navon targets before moving onto the experiment block. If they were unsuccessful, they were reminded of the instructions and repeated the practice block until they were successful (maximum number of repeats = 2).

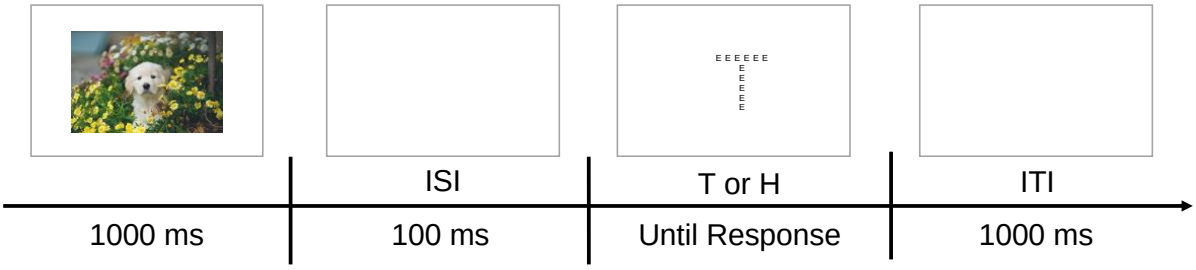
The experiment consisted of 144 trials (72 global level target, 72 local level target, randomly intermixed). Each of the 24 negative-high, 24 neutral-low and 24 positive-high affective-prime pictures were presented twice, once paired with a global-target Navon and once with a local-target Navon. Affective-prime type was also randomly intermixed. Two rest breaks were offered throughout the experimental block.

Next, participants rated all 72 affective-primes on motivational intensity (ranging from -4 (*avoid*) to +4 (*approach*); with a neutral mid-point (0)) and valence (ranging from -4 (*unpleasant*) to +4 (*pleasant*); with a neutral mid-point (0)). The rating type was blocked, meaning that participants rated all pictures first on either motivational intensity or valence. The

order in which each participant completed the rating scale blocks was randomised, and within each block, picture presentation was randomised. Prior to each block, participants began by rating the six practice neutral pictures used in the affective-prime and Navon task on the respective scale for that block. See Chapter 6 Appendix B for instructions and rating scales used in the rating task.

Participants then completed the demographics questionnaire, which asked participants their age, gender, whether they had normal-or-corrected to normal vision, handedness, country of birth, country spent most time, whether English was their first language, and whether they had received a diagnosis of ADD/ADHD, Asperger's or another Autism Spectrum Disorder, Schizophrenia, or any major neurological illness (e.g., stroke, Parkinson's disease, or any major head injury requiring hospitalisation). They were then shown 20 positive pictures from the Internet to mitigate any negative emotional effect caused by the emotionally evocative pictures. Participants were then debriefed and provided with details to contact if in distress before leaving the laboratory.

Figure 6.2 *Example of a Single Trial Used in the Affective-prime and Navon Task in Experiment 1*



Note. The picture here is from the Internet (https://unsplash.com/photos/DsGeUBaJPwc) and not used in the current study, but it embodies the type of picture used in the 'positive-high' affective-prime condition.

6.6 Results

6.6.1 Data Screening

The data was obtained from raw data files and assembled using specific code in MATLAB. Data analysis was then performed using SPSS and JMP 15.2.0.

6.6.1.1 Picture Rating Task. 0.07% (13 ratings) of individual ratings were missing from the final participant sets data. The missing data was omitted from that participant's ratings data set (minimum number of ratings per participant = 61). Please see Table 6.1 for the means and standard deviations for the motivational intensity and valence rating scales across each of the affective-prime conditions.

Table 6.1 *Means and Standard Deviations for Motivational Intensity and Valence Ratings Across Affective-prime Conditions (N = 63)*

Affective-prime Condition	Rating Scale			
	Motivational Intensity		Valence	
	M	*SD*	*M*	*SD*
Negative-high	-2.56	1.00	-2.66	0.64
Neutral-low	0.00	0.38	0.02	0.36
Positive-high	2.34	0.87	2.23	0.81
Total	-0.07	2.15	-0.14	2.10

Note. Motivational intensity range: -4 (*avoid*); +4 (*approach*); 0 (*neutral*). Valence range: -4 (*unpleasant*); +4 (*pleasant*); 0 (*neutral*).

6.6.1.2 Affective-prime and Navon Task. Participants' accuracy in identifying the target letter on the affective-prime Navon task was measured to ensure task compliance. The primary dependent variable was their RT to identify the target on correct-response trials was measured. Individual trials were excluded from further analysis if they were quicker than 100 ms or slower than 3 SDs above the participants' mean (average correct RTs for each single affective-prime condition, e.g., participant correct RT average for negative-high trials only)

(see Goodhew et al., 2020 for recommendations of these cut-offs). This resulted in an exclusion of M = 1.56% (SD = 2.02%) of total trials per participant. See Table 6.2 for average accuracy on all affective-prime global and local Navon level conditions.

Table 6.2 *Average Accuracy on all Affective-Prime Global and Local Navon Level Conditions (N = 63)*

Affective-prime Condition	Navon Level	
	Global Mean % (SD%)	Local Mean % (SD%)
Negative-high	98 (2.72)	98 (2.88)
Neutral-low	98 (3.28)	97 (3.48)
Positive-high	97 (3.37)	97 (2.88)
Total	98 (3.13)	98 (3.08)

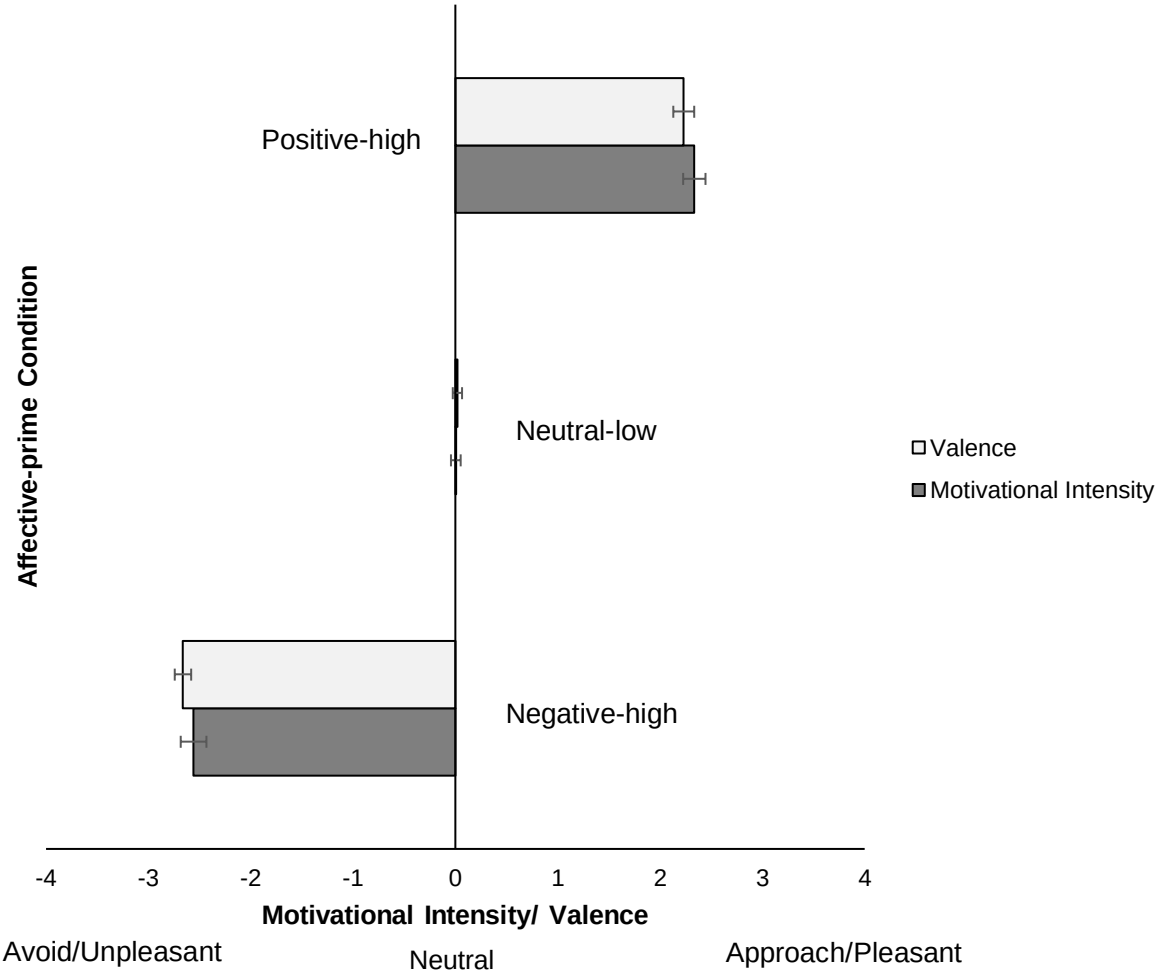
6.6.2 Data Analysis Plan

To test whether the affective-prime conditions induced participants into the intended affective states, we ran a repeated measures ANOVA on participants' average picture ratings to assess if average ratings on the rating scales varied as a function of affective-prime condition. To assess if attentional breadth varies as a function of affective-prime condition, we ran a repeated measures ANOVA on Navon global and local level RT for correct trials only to determine if attentional breadth varies as a function of affective-prime condition. As an additional analyses to assess if individual differences of emotional and motivational experiences play a role in attentional breadth modulation, we also ran a Linear Mixed Model (LMM) analysis on JMP 15.2.0 to assess the relationship between participants' self-reported affect (motivational intensity, valence) in response to each picture and changes in attentional breadth. The dependent variable, here, was RT difference scores (local RT – global RT), and motivational intensity and valence were entered as fixed effects, and participants and picture stimuli as random effects.

6.6.3 Was the Emotion and Motivation Induction Successful?

To assess if the emotion and motivation induction was successful, we ran a 3 (affective-prime condition: negative-high, neutral-low, positive-high) by 2 (rating scale: motivational intensity, valence) repeated-measures ANOVA on the dependent variable of individual participants' average picture ratings. Mauchly's test will be used to assess for sphericity for any effects or interactions involving variables with greater than 2 levels, and that Greenhouse-Geisser correction would be used if Mauchly's is significant. Results indicated there was a main effect of affective-prime condition on average picture ratings, $F(1.182, 73.287) = 728.85$, $p < .001$, $\eta_p^2 = .92$, indicating that average picture ratings varied by affective-prime condition. The pattern of this effect can be seen in Figure 6.3. This pattern is consistent with the affective prime conditions inducing the intended affective states. Further, there was no main effect of rating scale on average picture ratings, $F(1, 62) = 3.53$, $p = .065$, $\eta_p^2 = .05$, suggesting participants' average ratings did not differ between the valence and motivational intensity scales, and there was no interaction between rating scale and affective-prime on average picture ratings, $F(1.378, 85.452) = 1.34$, $p = .255$, $\eta_p^2 = .02$, indicating that the effect of affective prime condition did not differ across rating scale (see Figure 6.3).

Figure 6.3 *Average Picture Ratings for Motivational Intensity and Valence Across Three Affective-prime Conditions (N = 63)*



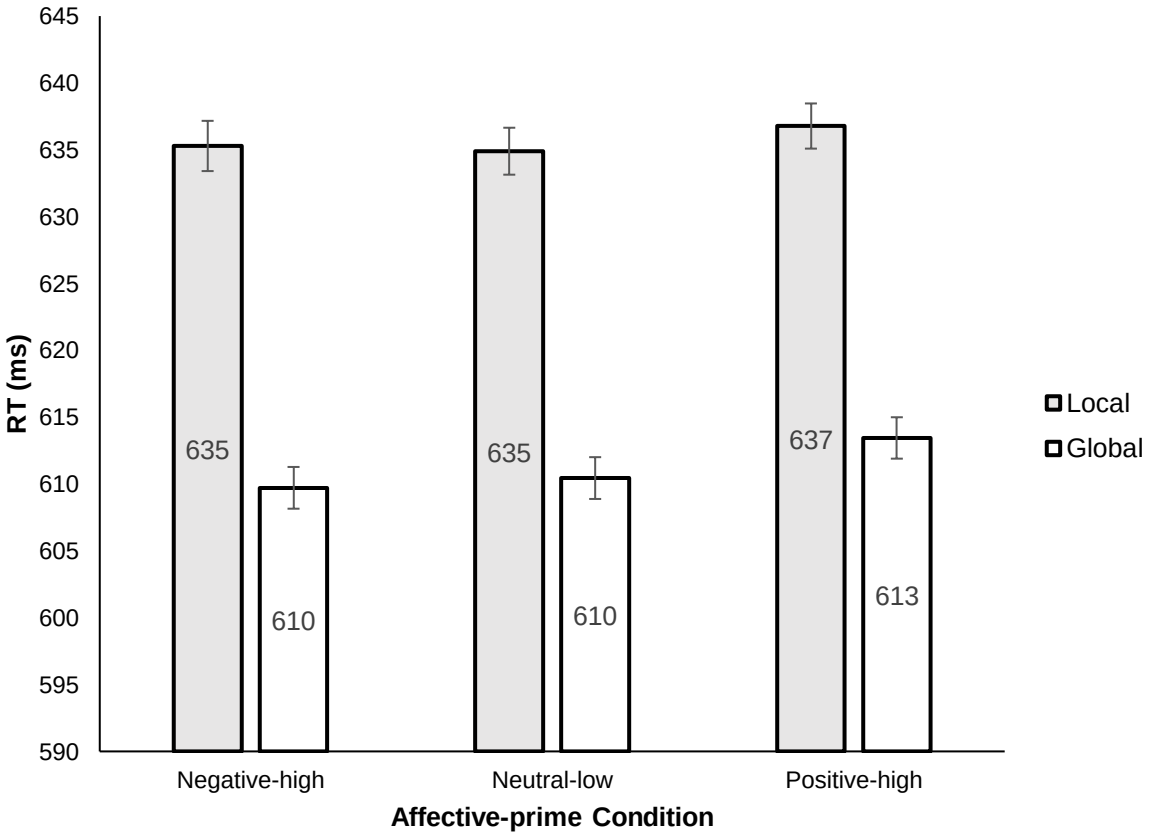
Note. Error bars represent SEMs. Motivational intensity range: -4 (avoid); +4 (approach); 0 (neutral). Valence range: -4 (unpleasant); +4 (pleasant); 0 (neutral).

6.6.4 Is There an Effect of Emotion or Motivation on Attentional Breadth?

To assess if there was an effect of emotion or motivation on attentional breadth a 3 (affective-prime condition: positive-high, neutral-low, negative-high) by 2 (Navon level: global, local) repeated measures ANOVA was run on the dependent variable Navon RTs for correct-trials. There was a significant main effect of Navon level on Navon RT, $F(1, 62) = 10.53$, $p = .002$, $\eta_p^2 = .15$, indicating that responses were faster for global trials ($M = 611$ ms, $SD = 119$ ms) compared with local trials ($M = 636$ ms, $SD = 136$ ms). This global advantage is the typical pattern seen with Navon stimuli (Kimchi, 1992; McKone et al., 2010; Navon, 1977,

1981). There was not a significant main effect of affective-prime condition on Navon RT, $F(1.821, 112.89) = .137$, $p = .853$, $\eta_p^2 =< .01$. There was also no significant interaction between affective-prime condition and Navon level on Navon RT, $F(2, 124) = .02$, $p = .978$, $\eta_p^2 < .01$ (see Figure 6.4). This means that affective-prime condition did not demonstrably alter attentional breadth.

Figure 6.4 *Navon Reaction Time Across Navon Levels by Affective-prime Condition (N = 63)*



Note. Error bars are SEMs.

6.6.5 Is there an Effect of Emotion or Motivation on Attentional Breadth at the Individual Level?

We also ran an MLM analysis to assess if emotion or motivation influenced changes in attentional breadth at the individual participant level. Motivational intensity and valence were entered into the model as fixed effects, and participant and picture stimulus as random effects. The difference score between local and global Navon RT was the response variable, as this

would act as an index for attentional breadth. Results revealed that neither of the fixed effects of motivational intensity (β = 0.002, *p* = .215) nor valence (β = -.001, *p* = .639) significantly contributed to the model. This indicated that there was no effect of motivational intensity or valence on attentional breadth at the individual level. Please see Chapter 6 Appendix C for additional MLM analysis to support the current findings.

6.7 Discussion

The present study found no effect of motivational intensity or valence on attentional breadth, as measured by the Navon task. These findings were in the context of evidence from participants' ratings that the primes effectively produced the intended emotional and motivational states, and that the Navon task produced a typical global advantage (Navon, 1977). The finding that neither motivational intensity nor valence impacted attentional breadth is inconsistent with both the motivational-intensity and the valence-based models of the influence of emotion and motivation on attentional breadth (for reviews see, Fredrickson, 2001; Harmon-Jones, Gable, et al., 2012). However, these results are consistent with very recent evidence questioning whether motivational intensity or valence influence attentional breadth (Chan & Saunders, 2022). In the following *6.7.1 Theoretical Implications* section, the theoretical implications of these results as they stand are considered. Following this, in the *6.7.2 Limitations and Future Directions* section, potential methodological factors that could have driven this null result are considered, as well as future research directions to determine whether there is additional support for the conclusion that neither motivational intensity nor valence influence attentional breadth.

6.7.1 Theoretical Implications

The present results are consistent with the conclusion that neither motivational intensity nor valence influence attentional breadth—a conclusion that has also been offered in another recent study (Chan & Saunders, 2022). Taken together, these studies suggest that at least in

some circumstances, attentional breadth is impervious to these factors. How, then, to reconcile these findings with a body of work claiming that these factors do influence attentional breadth?

Firstly, it is possible that neither emotion nor motivation ever systemically influence attentional breadth. If so, then the studies that have made this claim may simply be Type 1 statistical errors or may be attributable to other factors. For example, form and texture cues influence attentional breadth, such that densely packed visual stimuli narrow attentional breadth compared to more sparse stimuli (Kimchi & Palmer, 1982). It could be that studies such as Gable and Harmon-Jones (2008a) who compared the effect of desserts versus rocks on attentional breadth and observed a narrowing of attention in response to desserts, could have done so because the dessert pictures were denser and the rock pictures sparser. In the current experiment, we sought to control for such effects by matching the stimuli, and this may be why we did not observe any modulation of attentional breadth.

Another possibility is that either motivational intensity and/or valence can modulate attentional breadth only under certain conditions, or only for some individuals. For example, it could be that individual difference factors, such as propensity for negative affect, moderate whether negative-valence stimuli influence attentional breadth. Indeed, it has been suggested that depressive symptoms moderate the relationship between positive mood and attentional breadth, in that for low levels of depression, positive mood was related to broadened attentional breadth while positive stimuli were presented, and during high levels of depression this relationship was opposite (Grol & Raedt, 2014). There are also individual differences in approach/avoidance tendencies (e.g., Gable & Poole, 2014; Harmon-Jones, 2003, 2007) that are candidate moderators here. Alternatively, it could be that individual propensities to have a broad or narrow attentional breadth in the absence of manipulations or task demands moderate these effects (Koldewyn et al., 2013; Lawrence et al., 2018). For example, individuals who prefer to adopt a narrower attentional breadth may be more susceptible to manipulations

designed to narrow their attentional breadth and less susceptible to manipulations designed to broaden them. Such factors have typically not been measured in the work in this literature, and thus future research will need to test such candidate moderating factors (Grol & Raedt, 2014; Lawrence et al., 2018).

It is also possible that emotion does impact attentional breadth, but valence is not the determinant of such effects. Instead, specific discrete emotions may do so. For example, previous studies have explored the relationship between affect and attentional breadth within specific categories of emotion (e.g., sadness), and found mixed results depending on the category of emotion examined (von Mühlenen et al., 2018). Changes in attentional breadth which depend on the category of emotion being used may explain why previous studies investigating the relationship between motivational intensity and attentional breadth did not look at multiple affective states within a single experiment, but used discrete emotions to explore the effects of emotion and motivational intensity on attentional breadth (e.g., only looked at approach-motivated positive affect; Gable & Harmon-Jones, 2008a). Some of the studies that have reported effects of motivational intensity on attention have been focussed on manipulating a specific discrete emotion (e.g., desire; Gable & Harmon-Jones, 2008a), and it is therefore possible that desire narrows attentional breadth, rather than motivational intensity.

6.7.2 Limitations and Future Directions

There are some methodological limitations that potentially prevented us from observing a true effect of emotion or motivation on attentional breadth if there was one to be found. Firstly, it is possible that the affect induction was not sustained long enough to exhibit any effect on attentional breadth. Some previous studies that have observed an effect of emotion and motivation on attentional breadth have used picture presentation times that were much longer in duration (e.g., 6 s; Gable & Harmon-Jones, 2008a). Therefore, it is possible that our 1 s affective-prime picture presentation was not long enough to produce lasting effects of

emotion or motivation on attentional breadth. That said, the current experiments picture presentation length was selected given ERP evidence that suggests emotional processing peaks between 400-700 ms (Bradley et al., 2007), and attentional breadth modulation occurs between 100-500 ms in most individuals (Goodhew & Plummer, 2019). Moreover, some previous studies have used shorter picture presentation durations (e.g., 500 ms and 3 s, Threadgill & Gable, 2019b; Yang et al., 2021) and obtained results that are consistent with an effect of emotion or motivation on attentional breadth. To assess if this potential methodological limitation has an impact on finding an effect, future studies could use blocked-designs with separate blocks for shorter (e.g., 1 s) and longer (e.g., 6 s) picture presentation times and assess if any differences emerge while using the different presentation times.

It is also possible that 'affect spilling' occurred because of the short inter-trial interval duration and the mixed presentation of affective-prime stimuli. Firstly, previous studies have used long durations for their inter-trial intervals, with some studies inter-trial intervals lasting 18-20 s (e.g., Study 2, Gable & Harmon-Jones, 2008a). Again, we chose a relative short inter-trial interval due to evidence on emotion processing and changes in attentional breadth (e.g., Storbeck et al., 2018; von Mühlenen et al., 2018). Second, due to concerns with the effects of one affective-prime condition spilling into another, some studies have looked at the effects of different affective-prime conditions by only presenting stimuli from one affective-prime condition (e.g., approach-motivated positive affect) versus neutral stimuli within a single experiment (e.g., Gable & Harmon-Jones, 2008a; Gable & Harmon-Jones, 2009; Gable & Harmon-Jones, 2010a). However, we included all three affective-prime conditions (positive-high, neutral-low, negative-high) in the one experiment because we wanted to assess the potential relative changes in attentional breadth. Other studies have also mixed affective-prime conditions within a single experiment and obtained results consistent with an effect of emotion or motivation on attentional breadth (e.g., Fredrickson & Branigan, 2005; Rowe et al., 2007).

To account for the possibility of affect spilling, future studies could assess if any differences emerge when mixed and blocked designs are used.

The affective-prime stimuli were designed to induce an affective state, and our goal was to investigate the influence of this state on attentional breadth. However, it is possible that the affective-prime stimuli may have been capturing attention separate from their influence on experienced affect, and that this may have contaminated the subsequent measure of attentional breadth. A recent study tested the effect of emotionally-salient stimuli to capture attention to their breadth on a Navon task (Goodhew & Edwards, 2022). However, the effects were limited to a subtle accuracy-based effect of small pictures contracting attention to match their level, only for individuals with high levels of Negative Affect. As a result, emotionally-salient stimuli capturing attention is unlikely to have a bearing on testing where larger pictures are used (which is more typical when assessing the influence of induced emotion on attentional breadth), and in participants not selected for their level of Negative Affect. That said, in the same previous study (Goodhew & Edwards, 2022) an effect that was robust was for large emotionally-salient pictures to slow responses to subsequent targets, regardless of whether those targets were local or global. However, designs like the one used in the current study would be able to show this effect if present, and it would come out as affecting both global and local RTs, not a selective breadth effect.

Even if these issues can be resolved, it is also possible that pictures are not the most appropriate manipulation technique when looking at the effects of emotion and motivation on attentional breadth. Can a picture really evoke a strong urge to avoid when the participant knows the situation is not real? On the one hand, the evidence does suggest that pictures can evoke emotion via physiological measures. For example, corrugator supercilii (frowning muscle) facial EMG activity is typically enhanced while viewing negative stimuli, and zygomaticus major (smiling muscle) facial EMG activity is typically enhanced while viewing

positive stimuli (Larsen et al., 2003). Further, evidence suggests that clinical populations (e.g., those with spider-phobias) show strong physiological responses (e.g., increased skin conductance response, ERPs, and startle responses) when presented with pictures of disorder-specific pictures (e.g., spiders, Mühlberger et al., 2006). Similar types of responses (e.g., increase in skin conductance activity) to pictures of threatening stimuli (e.g., animal threat, human threat, and mutilated bodies) are also present in the general population as seen in studies exploring physiological responses to IAPS pictures (e.g., Bradley, Codispoti, Cuthbert, et al., 2001). Therefore, it is clear that pictures can elicit emotional responses. On the other hand, however, it also remains likely that participants' cognitive knowledge and interpretations that the picture does not depict a real situation that they are experiencing may mitigate their emotional impact and their motivation to approach or avoid. Therefore, it may be that other types of stimuli or real-world stimuli may evoke more intense and/or complex emotional or motivational experiences not elicited by pictures alone, and that these may drive attentional breadth.

Another possibility is that rather than reporting how they actually felt, participants may have incorrectly reported their experience of emotion and motivation because they wished to behave in a way that would be considered socially-appropriate (e.g., Nath et al., 2020). For example, it is socially-appropriate to enjoy vegetables, but there are some individuals who may not. Therefore, such individuals who do not enjoy vegetables may feel inclined to report their experienced emotion and motivation inaccurately (e.g., high positive-approach motivation rather than high negative-avoidance motivation) in a bid to be perceived as responding socially-appropriately. Future studies could validate subjective ratings with objective measures (e.g., physiological) to confirm participants' subjective emotional and motivational experiences. For example, variations of the joy-stick task, or the manikin task (where a joystick or manikin is

moved towards or away to indicate approach and avoidance tendencies) could be used to validate approach and avoidance subjective ratings (Krieglmeyer & Deutsch, 2010).

6.7.3 Conclusions

In conclusion, the current work was designed to identify the true emotional or motivational driver of attentional broadening and narrowing. The results suggested that neither valence nor motivational intensity influenced attentional breadth. It could be that emotion and/or motivation only influence attentional breadth in particular contexts or for particular individuals. Alternatively, it is possible that the previous studies claiming that one of these factors influence attentional breadth could be attributed to other factors (e.g., systematic differences in the physical features of the emotion-eliciting pictures, which are known to influence attentional breadth), and that neither emotion nor motivation influence attentional breadth. Future research will be needed to test potential moderating factors and alternative explanations for purported effects of emotion or motivation on attentional breadth to determine if the results of the present study are indicative of attentional breadth being impervious to emotion and motivation more broadly.

Chapter 7: General Discussion

7.1 Thesis Aim and Highlights

The initial aim of this thesis was to examine if motivational intensity or valence drives attentional broadening and narrowing. However, a review of existing work highlighted that the literature would benefit from a more rigorous empirical assessment of whether motivational intensity was distinct from existing constructs of affect, namely arousal and valence. Through a series of foundational studies conducted as part of Chapter 3 of this thesis, where individuals were asked to rate their emotional and motivational experiences elicited by a large set of affective picture stimuli, a very strong correlation between motivational intensity and valence was observed (Campbell et al., 2021). Through further investigations as part of Chapter 4 of this thesis, when affective picture stimuli that represented specific discrete categories of emotion were investigated, a divergence between motivational direction (approach/avoidance) and valence (positive/negative) emerged for three key discrete categories of emotion: sadness, anger, and amusement (Campbell et al., 2022). Given that these foundational studies revealed that motivational intensity is not always synonymous with valence and identified instances where they diverge, we were able to return to the original aim of the thesis in Chapter 6 and directly pit motivational intensity against valence to determine which (if either) drives attentional broadening and narrowing. Claims had been made about motivational intensity and valence separately being drivers of changes in attentional breadth. However, existing empirical testing of the effect of each of these emotion and motivation components on attentional breadth had failed to fully control for the other component, meaning that there was no existing work that could adjudicate between these competing theoretical models (e.g., Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a, 2010a; Rowe et al., 2007).

There are several highlights from this thesis, which have broader implications for work carried out in the field of emotion and cognition:

Highlight 1: Arousal is not an appropriate proxy for motivational intensity. Previous studies (that used arousal as a proxy for motivational intensity) results should be re-evaluated.

Highlight 2: There is a high degree of correspondence between experiences of motivational intensity and valence. However, there are some specific instances where they can diverge, including during sadness, anger, and amusement.

Highlight 3: There are individual differences in motivational direction responses. For example, some people want to approach, and others want to avoid the same affective stimulus. This pattern contrasts with that for valence, where different individuals generally respond consistently across one polarity of valence (e.g., all participants report feeling negative/unpleasant to the same affective stimulus).

Highlight 4: Appraisals play a role in driving individual differences in motivational direction responses. Specifically, helping appraisals (how useful, comfortable, and welcome an individual would feel offering help) play a role in predicting motivational direction during sadness.

Highlight 5: There was no evidence that either motivational intensity or valence influence attentional breadth, which supports recent findings suggesting there is no effect of motivational intensity or valence on attentional breadth (Chan & Saunders, 2022). However, this null finding may have resulted from stimulus timing not being optimal to gauge these effects, and so further investigation is needed to determine if our results are true, or to determine the true driver of attentional broadening and narrowing.

The current chapter outlines the broader implications of the thesis as a whole body of work and suggests possible avenues for exploration in future research.

7.2 Foundational Work is Needed to Validate Relationships Between New and Existing Constructs

It has been claimed that motivational intensity exists distinct from valence and arousal, and that motivational intensity supersedes valence as the explanatory mechanism for driving changes in cognitive scope (for reviews, see Harmon-Jones, Gable, et al., 2012; Harmon-Jones,

Price, et al., 2012). However, the convergence and divergence between motivational intensity and the existing concepts of valence and arousal was largely assumed rather than systematically tested. Therefore, a major contribution of the current body of work to the field is that across a diverse set of affective stimuli the relationship between motivational intensity, arousal, and valence was assessed (Campbell et al., 2021). The relationship between motivational intensity and valence was also assessed across discrete categories of emotion previously claimed to separate motivational intensity from valence (Campbell et al., 2022). Here, a high correspondence between motivational intensity and valence was found when a diverse range of stimuli were examined, but a divergence emerged when key discrete categories of emotion were assessed for sadness, anger, and amusement. Chapter 3 and 4 findings are important first steps for understanding the relationship between motivational intensity, arousal, and valence.

It could be argued that arousal and valence are not entirely independent. While given the results of Campbell et al. (2021) in isolation, an explanation such as individuals using valence to infer motivational intensity (or vice versa) is feasible, the results of Campbell et al. (2022) show that this is not the case. The results showed this was not the case because in Campbell et al. (2022), motivational intensity and valence diverged for certain emotional categories, and in fact, motivational intensity was driven by certain appraisals that valence was not.

However, to assess whether there is convergent evidence for the findings obtained here, the induction and measurement techniques for motivational intensity used in this thesis should be validated with corroborating evidence. Specifically, did the induction and measurement techniques of motivational intensity used as part of this thesis truly capture the motivational experience?

7.2.1 Inducing Motivational Intensity

Pictures were used to manipulate motivational intensity in the empirical Chapters 3, 4 and 6 of this thesis. While this choice was motivated by evidence that pictures are an effective means of manipulating motivational intensity, it is likely that there are aspects of the motivational experience that pictures do not fully capture. For instance, can a picture really evoke the same urge to approach that is experienced during anger (e.g., the urge to confront during an argument)? The mere fact that people know they are not experiencing a real situation may inhibit aspects of their motivational response which would be present if they experienced that situation directly in their everyday lives. Consequently, there are other manipulation techniques that could be used. Situational exposure manipulations have been used to evoke motivational states. For example, one study aimed to increase action expectancy by telling participants they will engage in an angry confrontation which was thought to heighten their motivation to approach (e.g., Harmon-Jones et al., 2006). In addition, some previous studies have used embodied cognition to induce motivational states, explicitly asking participants to lean forward and backward to evoke approach and avoidance motivation, respectively (e.g., Harmon-Jones et al., 2011a; Price & Harmon-Jones, 2010). Such approaches to manipulating motivational intensity could be used to assess if the same relationships with emotional valence and with appraisals are observed as when motivational intensity is evoked via pictures.

7.2.2 Measuring Motivational Intensity

In the studies conducted as part of this thesis in Chapters 3, 4, and 6, subjective ratings were primarily used to measure motivational intensity. The use of subjective ratings was motivated by existing evidence that participants can report on their emotional experiences in a way that corroborates with physiological evidence (e.g., Bradley et al., 2007; Bradley et al., 2008; Lang et al., 1998; Lang et al., 1993). However, do subjective ratings validly measure the motivational experience evoked? Some authors have argued that, in contrast to emotion,

motivational intensity is something that participants have difficulty providing subjective reports about (Gable et al., 2016). Further, rating scale measurement is vulnerable to other unwanted sources of variance, such as socially appropriate or desirable responding (e.g., Nath et al., 2020). For example, an individual may signify that they want to approach to help a person in distress, because they think that doing so is socially appropriate, rather than because they truly want to.

As part of an additional study in Chapter 3, an objective reaction time (RT) measure was used to implicitly measure motivational intensity responses (see Study 2, Campbell et al., 2021). As part of this task, participants were asked to respond to affective picture stimuli on a forced-choice RT task. Participants were instructed to select one of two keys (one that represented an urge to avoid, and the other that represented an urge to approach) as quickly as possible while viewing each picture stimulus. Interestingly, this study revealed that there were potential different sets of stimuli. That is, results showed faster RTs for pictures where motivation could be understood as automatic (e.g., strong avoidance: threatening stimuli, weapons; and strong approach: desserts, cute animals), and slower RTs for pictures that required decision-making about the persons urge to avoid or approach (e.g., erotica, hurt children and animals). In relation to the question of validity, it was those pictures that were rated as more extreme in approach/avoidance motivation that were easier to classify than those with weaker motivational intensity levels. It may be useful for future studies to validate subjective ratings with an objective measure like the one used as part of Study 2 in Chapter 3.

It would be useful for future work to directly test the validity of subjective ratings of motivational intensity by comparing these responses with other measures. There are other objective measures that can be used as well to measure motivational intensity. For example, the joystick or manikin task can be used to measure an individual's approach and avoidance motivation indirectly (e.g., Gračanin et al., 2018; Krieglmeyer & Deutsch, 2010; Sklenarik et

al., 2020). While such a measure avoids the requirement for explicit responses about motivational intensity, it does rely on the assumption that these motor behaviours selectively reflect approach and avoidance motivation. It will be interesting for future research to assess the extent to which the findings in the studies reported here generalise to such measures.

Physiological measures could also be used to validate motivational intensity experiences. When arousal and valence were first introduced (Bradley et al., 2007; Bradley & Lang, 2007b; Cuthbert et al., 2000; Lang et al., 1997; Lang et al., 1993), physiological measures were used to validate subjective ratings of emotional responses, including facial EMG, skin conductance, heart rate measures, and so on (Bradley & Lang, 2007a). In particular, facial EMG studies have validated subjective negative valence with activation of facial muscles associated with frowning and subjective positive valence with activation of facial muscles associated with smiling, while subjective arousal covaries with skin conductance (Lang et al., 1993; Larsen et al., 2003). This same approach could be applied to motivational intensity. However, the difficulty with this approach is that it is not as immediately clear what the appropriate physiological signal to measure motivational intensity would be.

That said, one possible physiological measure of motivational intensity could be the startle eyeblink and post-auricular reflex modulation (Benning, 2011; Bradley, Codispoti, Cuthbert, et al., 2001). The startle eyeblink and post-auricular reflex modulation are closely linked to motivational priming (as opposed to more diffuse autonomic responses). Motivational intensity could be measured by presenting startle probes about 3 seconds after stimulus onset on a small subset of trials. Avoidance motivational priming should result in potentiation of the startle response during unpleasant pictures, and approach motivational priming should result in potentiation of the post-auricular reflex during pleasant pictures. It will be interesting for future research to test the relationship between such physiological measures and subjective

ratings of motivational intensity, and to assess whether the relationships observed in the studies here generalise to such physiological measures of motivational intensity.

7.3 Individual Differences in Motivational Direction Responses

The present body of work revealed that there are stark individual differences in motivational direction responses (e.g., variation across approach and avoidance responses on the same stimulus), whereas there was a high degree of agreement on the polarity of valence (e.g., negative responses only to the same stimulus) (see Chapter 4).

These individual differences in motivational direction responses have implications that may impact the interpretation of previous studies conclusions. Specifically, previous studies that examined the influence of motivational intensity on cognitive processing attributed any cognitive changes to group-level motivational intensity (e.g., low group-level motivational intensity evoked during sadness; Gable & Harmon-Jones, 2010a). However, work carried out as part of this thesis (Chapter 4) has revealed that there are individual differences in motivational direction responses (e.g., some people want to approach, and others want to avoid the same stimulus). Consequently, the group-level motivational direction may vary depending on the sample population used for the specific study, and previous studies that assumed a certain motivational direction may have incorrectly attributed a motivational direction level to the observed changes in cognitive processing (e.g., Gable & Harmon-Jones, 2008a, 2010a). Therefore, it is recommended that future studies collect and report individual ratings of motivational direction and intensity when exploring the impact of the effect of motivational direction and intensity on psychological processes.

7.3.1 Role of Appraisals in Explaining Individual Differences in Motivational Direction

Literature indicates that appraisals drive valence (Ellsworth & Scherer, 2003; Frijda et al., 1989; Siemer et al., 2007). However, work carried out as part of this thesis in Chapter 4 (Campbell et al., 2022) revealed that appraisals also play a role in predicting motivational

direction. The work carried out in Chapter 4 was a preliminary investigation into whether the variation in motivational direction responses could be predicted by appraisals. Specifically, findings indicated that helping appraisals play a role in predicting motivational direction responses during sadness. Overall, current findings demonstrate that there are specific avenues within the appraisal and motivational direction space that could be explored in future research.

Firstly, keeping our focus on the specific discrete emotional category explored in Chapter 4, sadness, future studies could investigate if there are sub-categories that exist within sadness that can be linked to specific helping appraisals when grouped together. For example, are situations that evoke grief (a sub-category within sadness) specifically linked to the comfort appraisal, and hence the associated motivational direction. For example, when an individual experiences a sad situation that evokes grief, could it be that they will only approach if they feel comfortable helping?

Another area that could be explored involves assessing the relationship within other discrete emotional categories (e.g., anger or amusement). Chapter 4 findings revealed that helping appraisals predicted motivational direction during sadness. However, are there other appraisals specific to other discrete emotional categories that predict motivational direction? For instance, could appraisals regarding an individual's safety (e.g., how unsafe or safe they feel in a situation) predict their motivation to approach or avoid during anger?

The third area that could extend on the work carried out as part of this thesis could be to look at what predicts how an individual makes an appraisal in a specific situation. What exactly drives an individual to feel comfortable to help and therefore approach in a sad situation? There are numerous possibilities that may drive appraisals in different situations, including state-level emotions, familiarity, trait-level qualities, social identity, learning history, personal relevance, and so on. For example, may we be more inclined to feel comfortable helping and therefore approach an individual in a sad situation if they are a member of our in-

group? Or may we feel less comfortable helping and therefore avoid the same situation if the individual involved is a member of our out-group?

7.4 Does Motivational Intensity or Valence Drive Attentional Breadth?

A key contribution of this body of work is that it is the first empirical test comparing two major competing theoretical models, where each claim that a specific component of emotion or motivation drives attentional broadening and narrowing. To assess this, in Chapter 3 and 4 (Campbell et al., 2021, 2022) subjective ratings of motivational intensity were used and compared with subjective ratings of valence before assessing their independent effects on attentional breadth in Chapter 6. These findings were also validated further using an RT measure in Experiment 2 of Chapter 3 (Campbell et al., 2021). Overall, the results in Chapter 6 revealed no significant effect of motivational intensity or valence on attentional broadening and narrowing. On one hand, the results in Chapter 6 conflict with previous findings supporting the motivational-intensity based model (Harmon-Jones et al., 2013) and the valence-based model (Fredrickson, 2001), because neither of these aspects had any demonstrable impact on attentional breadth. However, the null result is consistent with recent findings which showed no direct influence of motivational intensity or valence on attentional breadth (Chan & Saunders, 2022). Therefore, it is possible that neither emotion nor motivational intensity influence attentional breadth? Of course, these findings contrasts with a body of evidence that has found positive effects attributed to these variables (e.g., Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2008a, 2010a; Hicks & King, 2007; Rowe et al., 2007), and therefore further testing is required before this conclusion can be adopted with greater confidence. It may also be that emotion or motivational intensity can influence attentional breadth but only under specific circumstances or for specific individuals, and further testing is required to identify such potential moderating factors. For instance, it may depend on how strongly the stimulus being attended to (e.g., Navon letter) influences attentional breadth. That is, Navon stimuli

place specific task demands on the participant and therefore may strongly drive attentional breadth. Alternatively, what appeared to be effects of emotions elicited by the pictures in previous work may turn out to stem from non-emotional perceptual factors, such as more complex pictures narrowing attentional breadth (e.g., Gable & Harmon-Jones, 2008a, 2010a).

Therefore, while the design used in Chapter 6 may need tweaking in terms of the presentation duration of the pictures to elicit any effects of the pictures, it is believed that fundamental aspects of the design – such as directly comparing two different dimensions – should help to inform and inspire future model-testing. Another important aspect of the design was collecting individual participants' ratings of stimuli and assessing how these relate to performance, rather than just relying exclusive on pre-determined categories based on normative ratings. Collecting individual participants' ratings is critical for motivational intensity and direction, given the individual differences observed in the Chapter 4 studies.

Finally, to extend on the current body of work, if the null results of motivational intensity and valence on attentional breadth observed in Chapter 6 are also observed under a range of other conditions (e.g., including with longer picture times), then it suggests that the role of emotion and motivation on cognition may have been overstated. Therefore, future studies may then also need to reassess if the effects of the attributed emotion or motivation experience on other cognitive processes included under the umbrella of cognitive scope (e.g., memory, cognitive categorization, or time perception; Harmon-Jones, Gable, et al., 2012; Harmon-Jones et al., 2013) are replicable. If they are, then similar designs where motivational intensity and valence (and arousal) are pitted against one another could be used for these cognitive processes would reveal which aspect drives these cognitive processes.

7.5 Conclusions

The current thesis carried out foundational studies which compared motivational intensity with valence and arousal, to determine the extent to which they converged and

diverged in response to a wide range of affective stimuli, and across key discrete categories of emotion that had been claimed should produce a divergence between motivational intensity and valence. Findings revealed that across a wide range of affective stimuli there was a moderate and inconsistent correspondence between motivational intensity and arousal, whereas there was a high degree of correspondence between motivational intensity and valence. However, when the relationship between motivational intensity and valence was investigated across a selection of discrete categories of emotion, a divergence emerged for key categories of emotion sadness, anger, and amusement. Following this, the first empirical assessment which pitted the motivational intensity model and the valence model against each other was conducted. However, we did not see an effect of either motivational intensity or valence on attentional breadth. Therefore, further investigations are needed to determine which (if either) of motivational intensity or valence is the primary driver of attentional broadening and narrowing.

Appendices

Chapter 6 Appendix A: Pictures

6A.1 Negative-high

6A.1.1 IAPS. 3064 (negative_01), 9600 (negative_02), 9342 (negative_03), 8485 (negative_04), 7380 (negative_05), 9187 (negative_06), 3000 (negative_07), 9302 (negative_08), 9635.1 (negative_09), 1300 (negative_10), 3060 (negative_11), 9291 (negative_12), 9570 (negative_13), 3001 (negative_14), 1050 (negative_15), 3068 (negative_16), 9571 (negative_17), 6560 (negative_18), 2811 (negative_19), 3103 (negative_20), 9410 (negative_21), 9325 (negative_22), 9904 (negative_23), 9413 (negative_24).

6A.2 Neutral-low

6A.2.1 IAPS. 1419 (neutral_01), 7026 (neutral_02), 7234 (neutral_03), 5120 (neutral_04), 7255 (neutral_05), 7010 (neutral_06), 2190 (neutral_07), 7014 (neutral_08), 7950 (neutral_09), 7233 (neutral_10), 2214 (neutral_11), 7004 (neutral_12), 7175 (neutral_13), 2880 (neutral_14), 7059 (neutral_15), 2493 (neutral_16), 7150 (neutral_17), 7056 (neutral_18), 7060 (neutral_20), 2104 (neutral_21), 7050 (neutral_22), 7090 (neutral_23), 2890 (neutral_24).

6A.2.2 Internet. funny_1 (neutral_19).

6A.3 Positive-high

6A.3.1 IAPS. 1710 (positive_01), 5825 (positive_02), 5833 (positive_03), 5829 (positive_04), 1750 (positive_06), 1440 (positive_10), 1460 (positive_13), 1410 (positive_16), funny_12 (positive_17), 1920(positive_18), 2332 (positive_24).

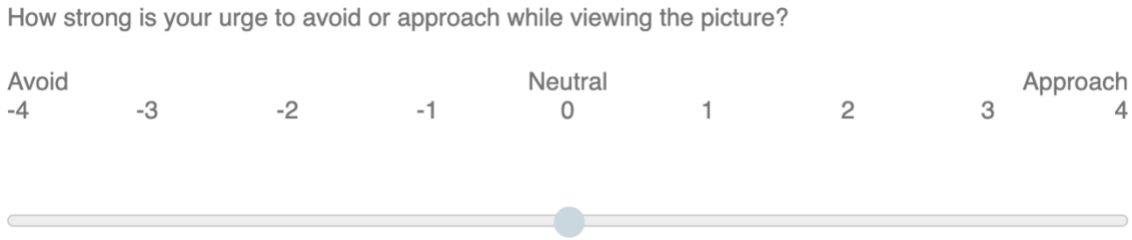
6A.3.2 Internet. delicious_8 (positive_05), cat_04.jpeg (positive_07), delicious_5 (positive_08), cat_08 (positive_09), funny_4 (positive_11), delicious_4 (positive_12),

funny_9 (positive_14), cat_06 (positive_15), funny_7 (positive_19), funny_3 (positive_20) cat_12 (positive_21), cat_02 (positive_22), delicious_1 (positive_23).

Chapter 6 Appendix B: Definitions and Instructions for the Motivational Intensity and Valence Rating Tasks

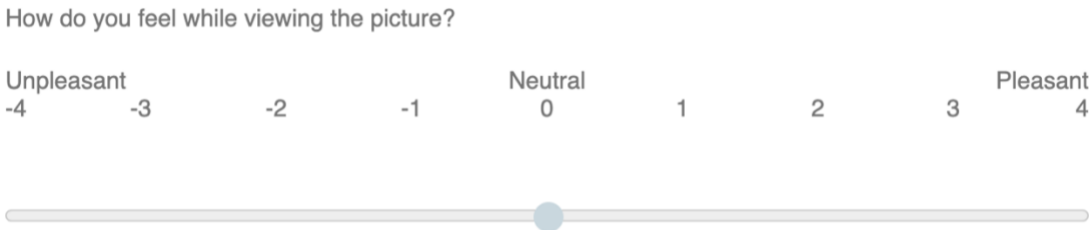
6B.1 Motivational Intensity Rating Scale

In this task you will see a series of pictures and be asked to indicate
the **strength of your urge to avoid or approach while viewing each picture**
by moving the slider to the corresponding point on the scale.



6B.2 Valence Rating Scale

In this task you will see a series of pictures and be asked to indicate
how unpleasant to pleasant you feel while viewing each picture
by moving the slider to the corresponding point on the scale.



Chapter 6 Appendix C: Multi-Level Modelling Tables for the Effect of Emotion or Motivational Intensity on Attentional Breadth at the Individual Level

Table 6C.1 *Various Models Produced to Assess the Effects of Motivational Intensity and Valence on Attentional Breadth at the Individual Level*

	Model 1 Absolute local-global RT as Response	**Model 2 Relative local-global RT as Response**	**Model 3 Relative local-global RT as Response**
Fixed Effects	β (*p*)	β (*p*)	β (*p*)
Motivational Intensity	.006 (0.064)	.005 (.190)	.001 (.450)
Valence	-0.001 (.648)	-0.000 (.938)	.000 (.952)
Affective-prime	(.387)	(.564)	
Random Effects	*p*	*p*	*p*
Participant	.000	.001	.000
Picture Stimulus	.568	.597	.635
Model Fit	Adjusted R^2 %	Adjusted R^2 %	Adjusted R^2 %
	4.58	4.21	4.24

Note. Relative local-global RT = local-global RT/ mean local and global RT as recommended by Goodhew et al. (2020).

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