The Effects of Meditation on Attentional Capacity, Emotion Regulation, and Sensory Information Processing

A Thesis Submitted for the

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by

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Thesis Abstract

Emerging evidence suggests beneficial effects of meditation generally, and mindfulness meditation specifically, on mental health and well-being via improved cognitive functioning and emotion regulation. The exact mechanisms underlying these effects, however, are yet to be fully understood, which is an overarching aim of three related studies reported in the thesis. One possible mechanism facilitating both more efficient attentional processing and emotion regulation in meditators is reduced *attentional capture* by salient stimuli, quantified in the present research using *Attentional Blink* (*AB*) phenomenon - a temporary inability to consciously perceive an attended stimulus when it is shortly preceded by another. Previous research using *AB* paradigms with neutral and emotional stimuli (referred to as *Neutral Attention Blink* (*NAB*) and *Emotional Attentional Blink* (*EAB*) paradigms, respectively) has shown that meditation practice (particularly mindfulness as secularly defined) attenuates *NAB*. Lower *NAB* has also been associated with higher trait *non-reactivity* (an aspect of mindfulness), both dispositional (innate) and trained through meditation practice.

Study 1 (online behavioural study) investigated the effects of meditation on *AB* using both the *NAB* and *EAB* paradigms in meditators (n = 75) and non-meditators (n = 54), as well as the relationships of *NAB* and *EAB* magnitude with each other and with trait *non-reactivity* and *equanimity* (non-attachment), with the latter being another aspect of mindful awareness that should attenuate *attentional capture* by salient (emotional) stimuli. There were no significant *NAB* or *EAB* differences between meditators and non-meditators. However, lower *EAB* was significantly associated with higher trait *non-reactivity* and *equanimity* in meditators as a group and in the meditator practicing mindfulness as secularly defined, suggesting that *non-reactivity* and *equanimity* might be attenuating *EAB* via reduced *attentional capture* by emotional stimuli.

Another mechanism that has been proposed to underlie *AB* is 'gating' or filtering of the sensory stimuli as a way to protect the processing of the first stimulus, given limited attentional capacity resources. Sensory gating is a fundamental mechanism protecting limited attentional processing capacity by an automatic inhibition of subsequent stimuli whilst the current stimulus is being processed and has been extensively studied using *Prepulse Inhibition* (*PPI*) – a modulation of the startle reflex when a startling stimulus (*pulse*) is preceded by a stimulus of less intensity (*prepulse*). ***Study 2*** (lab-based study) explored the relationships of *PPI* with *AB* (with the focus on *NAB*) as well as with trait *non-reactivity* and *equanimity* in a separate sample of meditators (n = 23) and non-meditators (n = 21). There were no significant *PPI* differences between meditators and non-meditators and no significant associations of *PPI* with trait *non-reactivity* or *equanimity*. However, higher *PPI* was significantly associated with slower reaction times during *NAB* paradigm performance. The implications of this finding for the shared (or similar) mechanisms underlying *AB* and *PPI* are not clear, but given that *PPI* is an index of sensorimotor gating, they point to the relationship between automated (*PPI*) and voluntary (*NAB*) motor aspects engaged by the two paradigms.

Yet another mechanism by which *non-reactivity* and *equanimity* might exert their attenuating effect on *AB* is the reduced activation of associative semantic memory networks in response to conceptually meaningful and/or emotionally salient stimuli, which has been observed in meditators in previous research. Associative semantic memory networks activation, alongside *attentional capture*, has been proposed as one of the mechanisms underlying the *Affective Priming (AP)* phenomenon – an impact that a first stimulus (*prime*) has on the speed and evaluation of the subsequent stimulus (*target*). ***Study 3*** (online behavioural study) investigated the effects of meditation on *AP* and its relationship with *EAB* as well as trait *non-reactivity* and *equanimity* in meditators (n = 49) and non-meditators (n = 55) (a subsample of *Study 1* participants). *Congruent* (same valence of *primes* and *targets*) and *incongruent* (opposite valence of *primes* and *targets*) were used in the *AP* paradigm. As expected, meditators were less impacted by the emotional valence of the *primes* or their congruity/incongruity with the targets, whereas non-meditators (particularly females) showed a strong priming effect. The correlation pattern between *AP* and *EAB* was somewhat inconsistent. Lower *AP* was associated with higher trait *non-reactivity* and *equanimity* in meditators for *incongruent* condition, suggesting that smaller *AP* in meditators may be due to reduced activation by the *primes* of associative semantic networks.

Together, the findings highlight trait *non-reactivity* and *equanimity* as the mechanisms underlying the effects of meditation generally, and mindfulness meditation specifically, on attentional capacity and emotion regulation via reduced *attentional capture* and semantic associative network activation by affective stimuli. Longitudinal studies using the *AB*, *PPI*, and *AP* paradigms are required to further investigate where the observed cross-sectional and correlational findings are the effects of meditation rather than pre-existing individual differences between meditators and non-meditations (and within meditators) with the view of developing particularly *AB* and *AP* paradigms as objective tools of meditation practice on attentional capacity and emotion regulation.

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"ومن سلك طريقًا يلتمس فيه علما سهل الله له به طريقًا إلى الجنة"

The Messenger of Allah (ﷺ) said,

"*God makes the way to Heaven easy for him who treads the path in search of knowledge.*"

For my mother, who dreamed of seeing her daughter hold the title of Dr.

For my father, who wanted her daughter to serve humanity.

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List of Abbreviations

Abbreviation	*Meaning*
AB	*Attentional Blink*
ANCOVA	*Analysis of Co-Variance*
ANOVA	*Analysis of Variance*
AP	*Affective Priming*
BOLD	*Blood-Oxygen-Level-Dependent*
CAMS	*Cognitive Affective Mindfulness Scale*
DERS	*Difficulties in Emotion Regulation Scale*
EAB	*Emotional Attentional Blink*
EEG	*Electroencephalography*
EMG	*Electromyography*
FA	*Focused Attention*
FFMQ	*Five Facet Mindfulness Questionnaire*
FMI	*Freiburg Mindfulness Inventory*
fMRI	*Functional Magnetic Resonance Imaging*
Hz	*Hertz*
IRI	*Interpersonal Reactivity Index*
KIMS	*Kentucky Inventory of Mindfulness Skills*
MAAS	*Mindful Attention Awareness Scale*
MaSD	*Mindfulness as Secularly Defined*
MBI	*Mindfulness-Based Intervention*
MBCT	*Mindfulness-Based Cognitive Therapy*
MBSR	*Mindfulness-Based Stress Reduction*
Ms	*Milliseconds*
MHQ	*Mindfulness History Questionnaire*
MQ	*Mindfulness Questionnaire*
NAB	*Neutral Attentional Blink*

NAS-7	*Non-Attachment Scale*
OM	*Open Monitoring*
OMT	*Other Meditation Traditions*
OP	*Open Presence*
PCA	*Principle Component Analysis*
PPI	*Prepulse Inhibition*
PTSD	*Post-Traumatic Stress Disorder*
RA	*Response Accuracy*
rmANOVA	*Repeated measures Analysis of Variance*
RSVP	*Rapid Serial Visual Presentation*
RT	*Reaction Time*
SD	*Standard Deviation*

Chapter 1: General Introduction

1.1 Concept of *Mindfulness*

1.1.1 Origins of the term *Mindfulness*

Tracing back 2550 years, mindfulness finds its roots in Eastern contemplative practices which stem from the Buddhist tradition. The term *mindfulness* was offered as one of the translations of the Pali term *sati* (Sanskrit term: *smrti*) by Thomas William Rhys Davids, a British scholar of the Pali language, in the Pali-English language dictionary (1921-1925). Additional translations that were provided included *intentness of mind, wakefulness of mind, lucidity of mind, consciousness*, along several others. The meaning of this term in colloquial Pali language simply means *memory* or *recollection* (Dreyfus, 2011). However, in the context of contemplative practice within the early Buddhist texts, namely the Buddhist *Abhidharma* literature, *mindfulness* is defined as a 'mental faculty that keeps guard of the mind'. Similar to a cognitive construct of working memory, it conveys the process of *remembering to keep attention on* a task or target object during contemplative practice or daily activities, and *remaining aware of* the task or target object without drifting away (Dreyfus, 2011; Kabat-Zinn, 2011).

1.1.2 Secular Definition of *Mindfulness*

Influenced by Buddhist psychology and practices, Jon Kabat-Zinn established the term *mindfulness* in a secular, scientific and clinical context, and defined it as 'paying attention in a particular way: on purpose, in the present moment, and non-judgmentally' (Kabat-Zinn, 1990). Consequently, he introduced a more comprehensive definition denoting *mindfulness* as 'the awareness that arises when paying attention on purpose, in the present moment, and non-judgementally' (Kabat-Zinn, 2005).

This latter definition captures *mindfulness* as: i) the *ability* of directing attention towards experiences; ii) the *process* of doing so without engaging in conceptual elaboration upon the present-moment experience and habitual judgements of those experiences as 'unappealing or appealing', 'dislikeable or likeable', 'unpleasant or pleasant'; and iii) the *awareness* that arises as a 'result' of employing the *ability* (attention) and applying the *process* (Antonova et al., 2021). This 'resulting' *mindful awareness* contains qualities of receptiveness, openness, acceptance and *non-reactivity* towards all experiences, whether thoughts, emotions, physical sensations, or sensory perceptions (Antonova et al., 2021). The terms synonymous with *mindful awareness* that are used in secular context include '*choiceless awareness'* (Kabat-Zinn, 1990), '*open presence'* (Lutz et al., 2007) or '*non-dual mindfulness'* (Dunne, 2011).

The distinctions between *mindfulness* as an *ability*, *process* and '*result'* are important to keep in mind when understanding mindfulness-related research, since *mindfulness* as the *ability*, *process* and '*result'* would appear distinct in terms of cognitive, emotional, and neural processes in individuals that have never engaged in mindfulness-based practices, mindfulness practice beginners, and experienced mindfulness practitioners. Therefore, it is important to take into account the aspects of *mindfulness* being studied (*ability, process* or *result*) as well as the experience and expertise in mindfulness practice when investigating mindfulness-related effects on cognition, emotion, behaviour, sensory information processing, and so forth (Antonova et al., 2021).

The operational definition of *mindfulness* introduced for the purpose of scientific research emphasises two components: i) self-regulation of attention maintained on the present-moment experience and ii) adopting particular orientation towards the present-moment experience with curiosity, openness, and acceptance (Bishop et al., 2004). Self-regulation of attention denotes a non-elaborative awareness of physical sensations, emotions and thoughts from one moment to the next. Orientation to experience refers to a stance held towards one's experience without the habitual tendency to relate to those experiences in judgemental and reactive ways (Bishop et al., 2004).

Most other definitions offered by researchers emphasise the non-judgemental nature of *mindfulness*, e.g. "the non-judgmental observation of the ongoing stream of internal and external stimuli as they arise" (Baer, 2003) whereas others highlight it as "the awareness that arises through intentionally attending in an open, accepting and discerning way to whatever arises in the present moment" (Shapiro, 2009) in addition to "an open and receptive attention to and awareness of ongoing present moment experiences" (Brown & Ryan, 2004). However, despite somewhat different emphasis on the aspects of *mindfulness* as a process as well as the qualities of the 'resulting' *mindful awareness*, all definitions distinguish *mindfulness* from ordinary attention and awareness by the self-regulatory capacity, present-moment centredness, and particular orientation or attitude toward the experience, with the latter being the most fundamental characteristic of *mindfulness.*

1.1.3 Differences in the Western and Buddhist Use of the Term *Mindfulness*

The conceptualisation of *mindfulness* within the *Buddhist contemplative* context (i.e. classical Buddhist texts, philosophy, meditation praxis methods, etc.) and the *secular* context (i.e. contemporary psychology, clinical and scientific research) differ to some extent. The most important difference is that within the traditional Buddhist context, it does not make sense to speak of *mindfulness* versus other forms of meditation, since every contemplative practice, including meditation, requires the mental faculty of *mindfulness* (as discussed in Section 1.1.2). However, within the secular context, *mindfulness* meditation refers to a meditation approach of a particular type, which requires openness and receptivity of the field of awareness whilst leaving the contents of awareness just as they are, that is unmodified in any way, and is often contrasted with the concentration meditations as practiced within the Theravada tradition of Tibetan Buddhism, requiring inhibition of the sense perceptions to achieve a single-pointed concentration (e.g. Kabat-Zinn, 2011).

Furthermore, Buddhist and Western constructs of *mindfulness* differ at the level of *context* and *process*. At the level of *context,* Buddhism seeks to attain an end to all suffering (Thera, 1962), whereas an end-goal of Western secular *mindfulness* applications is stress-reduction and improvement of mental and physical well-being. At the *process* level*,* the Western approach, in most cases, does not introduce the concepts of impermanence and the 'non-self', whereas these concepts are much elaborated upon in the Buddha's teachings and contemplative practices of different Buddhist traditions. Nonetheless, the beneficial effects of *mindfulness* on psychological well-being can be observed in both traditional Buddhist and modern contemplative *mindfulness* practices (Keng et al., 2011).

Finally, the term *mindfulness* in the Western secular context encompasses the awareness with certain qualities that arises as a 'result' of *mindfulness* practice, referred to as *mindful awareness* or *non-dual mindfulness* (Dunne, 2011) (see Section 1.1.2), whereas there are different terms for the accomplishment stage of contemplative practices in different Buddhist traditions, with the term *mindfulness* mainly reserved for the meaning of the Pali term *sati* (see Section 1.1.1).

Given these differences in the use of term '*mindfulness'* within Buddhism (and across its different traditions and approaches) and as intended by Jon Kabat-Zinn, there is no single definition of *mindfulness* in secular (research) context. Despite a proposed 'operational' definition of *mindfulness* by Bishop et al (2004), there is still considerable debate regarding its meaning, scope, and approach to meditation practice for it to be referred as *mindfulness*, partly due to (i) ongoing debates regarding the appropriation of meditative practices with regards to their derivation from traditional Buddhist sources that themselves use different definitions of mindfulness (e.g. Dreyfus, 2011; Dunne, 2011) (introduced in more detail in Section 1.1.3) and (ii) whether a researcher refers to it as an ability, process, or 'result'. Further complexities are added when considering *mindfulness*' conceptualisation within various contexts, e.g. mindfulness-based interventions (MBIs; discussed in more detail in Chapter 3, Section 3.2.1) should be framed in a manner that is accessible to not only researchers but also stakeholders including clinicians, patients and healthcare providers. This can limit the extent to which *mindfulness* can be fully captured by an operational definition, since its effects are typically much more holistic, involving an interplay of multiple processes/mechanisms and resulting effects. Instead of following one singular definition and/or construct of *mindfulness*, understanding *mindfulness* as a continuum of practices through a family resemblance approach (i.e. different cognitive processes resulting in different states within phenomenological dimensions) might be helpful and one way of addressing these differences, allowing different meditation practice styles and levels of meditation experience to be better understood through a phenomenological matrix (Lutz et al., 2015). Within this matrix, different meditative practice styles (e.g. Open monitoring, Open presence; more details in Section 1.1.5) are placed depending on the level of experience (i.e. novice or expert), the level of primary meditation-associated experiences (i.e. meta-awareness: more details in Section 1.1.6, dereification and object-orientation) and further symbolised by meditation-associated attributes (i.e. aperture, clarity, stability and effort). Understanding *mindfulness* through such a continuum is therefore more easily comprehensible and allows comparison with psychopathological-associated mental states (i.e. rumination, mind-wandering and addictive craving) also represented in the matrix.

1.1.4 Trait *Mindfulness:* Dispositional vs. Trained

The construct of trait *mindfulness* can be differentiated into '*dispositional* (innate) trait *mindfulness'* and 'trait *mindfulness* trained or acquired through *mindfulness* practices such as meditation, yoga', etc. (Rau & Williams, 2016). Dispositional trait *mindfulness* thus refers to the individual differences in the overall levels of mindfulness that are normally distributed in the general population (e.g. Brown & Ryan, 2003). Typically, individuals high on dispositional trait *mindfulness* are perceived to be more non-reactive when faced with distressing emotions, thoughts and sensations due to their awareness of automatic reactions to present-moment experiences (Garland et al., 2010). Recent research has further demonstrated that dispositional trait *mindfulness* is associated with structural and functional changes in brain structures implicated in attentional and emotional processes (Kong et al., 2016). Lower dispositional trait *mindfulness* has been linked to higher levels of Post-Traumatic Stress Disorder (PTSD), depression and substance use, highlighting its significance in mental health disorders (Pepping & Duvenage, 2016; Shorey et al., 2015). Conversely, individuals with higher levels of dispositional trait *mindfulness* have been shown to have higher well-being, as well as decreased physiological and flexible psychological responses to incoming stimuli (review, Keng et al., 2011). Regular *mindfulness* practice increases baseline (dispositional) levels of trait *mindfulness*, with this increase being associated with improved mental health (meta-analysis, Quaglia et al., 2016).

1.1.5 Stages of *Mindfulness* Practice Development

Mindfulness practice development in most Buddhist traditions typically proceeds in four stages, known as the 'Four Foundations of Mindfulness' as described in *Satipatthana Sutta*, a Buddhist text offering detailed meditation instruction: Stage 1 *Mindfulness of the body* (e.g. breath, body sensations); Stage 2 *Mindfulness of feelings and thoughts*; Stage 3 *Mindfulness of mind states* (e.g. drowsiness, boredom, etc.); and Stage 4 *Mindfulness of phenomena* (e.g. all experiences arising in the field of awareness). These four practice stages also form the core structure of the main MBIs, such as Mindfulness-Based Stress Reduction (MBSR, Kabat-Zinn, 1990) and Mindfulness-Based Cognitive Therapy (MBCT, Segal et al., 2002) (see Chapter 3, Section 3.1.2, for further details of MBSR and MBCT).

A common way of charting the trajectory of *mindfulness* practice development in western secular literature is the progression of meditation practice styles from Focused Attention (FA), to Open Monitoring (OM), to Open Presence (e.g. Lutz et al., 2007). FA meditation style uses a central point of focus (e.g. breath, visual object, mantra, etc.) to maintain attention on the present-moment experience without being distracted by thoughts, body sensations, or external stimuli (e.g. sounds). Thoughts and body sensations are detected but the practitioner is encouraged to disengage from these and to reorient attention back to the focal point (Lutz et al., 2008). OM meditation style has no explicit focus (anchor) of attention and maintains an open, receptive, non-judgemental awareness of the present-moment experience (Lutz et al., 2008). OM meditation style is further subdivided into 'object-oriented OM', which involves directing one's attention to thoughts, feelings, perceptions, and body sensations as they arise in the field of awareness, and a more advanced stage of 'awareness-oriented (or subject-orientated) OM', which involves sustaining awareness of awareness itself (Dahl et al., 2015). Once the practitioner learns to effortlessly maintain an open, receptive, non-judgemental, non-reactive, and non-elaborative yet cognisant awareness of the present-moment experiences, without either fixating on the objects of experience or identifying with an experiencing subject, they achieve the OP stage of practice as a way of being (Lutz et al., 2007).

The different stages of mindfulness practice development, the practice styles, as well as the practitioner's experience will be expected to have differential effects on cognition, emotion regulation and psychophysiology. The different stages of practice expertise also involve a different interplay between *fixation* ('grasping' in Buddhist terminology) (see Section 1.4.4), *distraction* as well as distinct types of *awareness* (Dalvinder & Grewal, 2014), which in turn will involve different underlying cognitive mechanisms. It is, therefore, essential to keep these in mind when studying the effects of meditation more generally, and *mindfulness* in particular, on attentional capacity, emotion regulation, and sensory information processing.

1.1.6 Classification of Meditation Practices

Meditation practice styles (and associated clinical interventions) have been categorised into three meditation families: *(1) Attentional, (2) Constructive,* and *(3) Deconstructive* (Dahl et al., 2015).

The *Attentional* family includes meditation practices that improve (i) attentional regulation (i.e. directing and/or maintaining attention, disengaging from distracters and reorienting attention) (Lutz et al., 2015; Tang et al., 2007) and (ii) meta-awareness (i.e. intentional awareness of the contents of consciousness) (Dunne et al., 2019). Practice styles in this family include FA (e.g. Jhana practice (Theravada Buddhism), breath counting (Zen Buddhism), body awareness practices (Zen/Tibetan Buddhism), Shamatha/calm abiding with support (Tibetan Buddhism), mantra recitation (various traditions) and OM, both object-orientated (e.g. choiceless awareness (Tibetan Buddhism), MBSR and MBCT components) and subject-orientated (Shamatha/calm abiding without support (Tibetan Buddhism) (Dahl et al., 2015).

The *Constructive* family includes meditation practices that foster (i) perspective-taking (i.e. awareness of another individual's mental state) and (ii) cognitive reappraisal (i.e. cognitive restructuring involving deliberate thought processes of an initial spontaneous reaction (e.g. thought, feeling) to an internal or external event that results in an altered response to them; see more details in Section 1.2.2). Practice styles in this family include those that enhance compassion, kindness, and interpersonal dynamics. Examples include Loving-Kindness and compassion practices (Theravada and Tibetan Buddhism) as well as such clinical interventions as compassion cultivation training and cognitively-based compassion training (Dahl et al., 2015).

The *Deconstructive* family includes meditation practices that employ self-inquiry (i.e. the introspective investigation of the nature and dynamics of conscious experience that maintain one's sense of self, including thoughts, feelings, body sensations, and perceptual appearances) to facilitate insight (i.e. an (often) sudden shift in knowing/understanding, conceptually, experientially or both, or consciously perceiving something that was previously obscured from/unclear in one's awareness), leading to profound transformation of one's consciousness. Practice styles in this family are directed towards understanding the dynamics of maladaptive cognitive, emotional, and perceptual schemas (habitual patterns) that leads to their undoing, resulting in potentially drastic 'revision' of the internal models of self, other, and 'reality'. Examples include OP or non-dual awareness (Mahamudra and Dzogchen of Tibetan Buddhism), Shikantaza or 'just sitting (Zen Buddhism), Vipassana/insight (Theravada) Muraqaba (Sufism), Self-inquiry (Advaita Vedanta), Transcendental meditation, MBCT components, Analytical Meditation (Tibetan), Dzogchen Analytical Meditation (Tibetan) (Dahl et al., 2015).

Although such typologies of meditation practices styles are helpful heuristics in terms of underlying cognitive processes to guide research into the mechanisms of change, it is important to acknowledge that such categorisations should be held loosely since most practices contain elements of all three families, either through explicit intention/instruction, required cognitive processes or spontaneous occurrences as a result of the practitioner's developing expertise. For example, compassion practices of Tibetan Buddhism are considered to be a 'royal highway' to realising the nature of mind (OP or non-dual awareness) as taught and practiced within Tibetan Buddhist approaches of Mahamudra and Dzogchen (Tsoknyi & Swanson, 2012). Similarly, a practitioner of secular approaches such as MBSR or MBCT might well achieve spontaneous transformative insights that would normally be facilitated by the OP style practices as they hold the same ‘effortless effort’ approach to meditation, even though MBSR or MBCT do not contain explicit instruction for achieving non-dual awareness or non-dual mindfulness (Dunne, 2011).

1.2 *Mindfulness* as an Emotion Regulation Strategy

Since one of the overarching research questions of this thesis explores how meditation practice in general, and mindfulness meditation (as secularly defined) in particular, impact the processing of emotionally evocative stimuli, this section provides background to emotion regulation and considers mindfulness as an emotion regulation strategy.

In short, emotion regulation is a modulation of one, or more than one, facet of emotional experience or expression. Emotion regulation encompasses all the conscious and unconscious strategies that enhance, maintain or attenuate (one or several) constituents of an emotional response. Emotion regulation includes both *automatic/non-conscious* and *voluntary/ conscious* psychological processes (Gyurak et al., 2011). These processes can either modify emotional experience or expression (Freudenthaler et al., 2017) or alter emotions in relation to their intensity, onset speed, duration, and recovery (Thompson, 1994). Emotion regulation enables individuals to stay inside a ‘window of tolerance’ that is optimal for social functioning and goal-directed engagement (Roemer et al., 2015).

1.2.1 Emotion Regulation Mechanisms

Contemporary psychology perceives emotion regulation to be a fundamental characteristic of mental health, and its underlying imbalances form an essential component of various mental health disorders. Adaptive emotion regulation results in attenuated negative emotions and increased resilience to stress, whereas maladaptive emotion regulation is instrumental in the progression and maintenance of psychiatric disorders. Various psychiatric conditions are driven by emotional instability and affective dysregulation (Koenigsberg et al., 2009), particularly depressive and anxiety disorders (Tang et al., 2016). Meditation practices help to cultivate adaptive emotion regulation strategies to promote healthy psychological functioning.

As with mindfulness, emotion regulation is a 'multifaceted' construct (Iani et al., 2018). The most validated and extensively researched model of emotion regulation is the model introduced by McRae & Gross (2020), outlining five phases of emotion regulation process*: [1] selection of a situation; [2] modification of a situation; [3] attention deployment; [4] cognitive reappraisal (cognitive change);* and *[5] modulation of experience, behaviour or response* (Gross & Jazaieri, 2014). Emotion regulation processes are thought to only alter, not eliminate, an emotional response completely (Grecucci et al., 2015). Consequently, this impacts behavioural, experiential, and physiological processes.

Additional models that encapsulate distinct elements of emotion regulation have also been introduced, including nine emotion regulation strategies: *[1] suppression of emotional expression and experience; [2] avoidance; [3] reappraisal; [4] acceptance; [5] distraction; [6] rumination; [7] problem-solving; [8] activities;* and *[9] social support* (Guendelman et al., 2017). Different emotion regulation strategies have their advantages; however, some strategies are fundamentally more beneficial and adaptive than others (McRae & Gross, 2020).

1.2.2 Cognitive Reappraisal and Expressive Suppression

Within cognitive psychology and neuroscience, significant empirical importance has been given to two specific cognitive emotion regulation strategies in particular: (i) *cognitive reappraisal* and (ii) *expressive suppression.*

Cognitive reappraisal involves actively re-evaluating an initial experience or event through re-interpretation that allows to modify and affect the unfolding trajectory of emotional experience, response and expression. Cognitive reappraisal is a key emotional regulation strategy that is consistently exercised in daily life (Gross & Jazaieri, 2014) and is particularly beneficial in down-regulating intense and extreme negative emotions as well as associated adverse physiological responses (Chambers et al., 2009; Hu et al., 2014).

Expressive suppression involves inhibiting outward emotional expressions during emotional arousal, either automatically/unconsciously or habitually (Todd et al., 2012). It could be adaptive in situations where inhibiting negative emotions (e.g. anger and anxiety) is beneficial to prevent escalation or to sustain effective social interactions. Despite advantages in some situations, evidence points towards its maladaptive effects (Sasaki et al., 2021; Sikka et al., 2022).

1.2.3 Mindful Emotion Regulation

Mindfulness facilitates a specific form of emotion regulation strategy referred to as *mindful emotion regulation* (Guendelman et al., 2017). It entails maintaining mindful awareness of any experienced emotions (i.e. with acceptance and without judgement or reactivity), regardless of their intensity or valence, with no modification, reappraisal or suppression (Salgó et al., 2021). It requires a combination of implicit and explicit psychological processes (Tang et al., 2016) and promotes higher endurance of unpleasant emotions (Reynolds et al., 2014). It is important to note that novice meditators might initially engage more top-down emotion regulation strategies involving active cognitive regulation when practicing mindful awareness of affective experiences to attenuate their intensity and associated distress; however, expert meditators rely on bottom-up strategies that do not involve cognitive effort (Chiesa et al., 2013; Hölzel et al., 2011; Taylor et al., 2011), moving with time and practice to greater emotional acceptance and more ‘openness’ towards emotional experiences (Hayes & Feldman, 2004).

Mindful emotion regulation is distinct from cognitive reappraisal or expressive suppression (Guendelman et al., 2017). Although cognitive reappraisal and mindful emotion regulation share some common characteristics (such as attention and meta-awareness), cognitive emotion regulation relies on modification of emotional experience to make it less distressing, whereas emotion regulation through mindful awareness requires allowing things to be as they are, with full acceptance, perceiving them as passing mental events (Segal et al., 2002). Emotional experience then dissipates if it is not fuelled by judgement, reactivity, or suppression.

Both mindful emotion regulation and expressive suppression rely on the bodily component of emotions, with suppression directed towards extinguishing bodily responses accompanying emotional experiences whereas mindful emotion regulation using the mindful awareness of body sensations to ‘nip in the bud’ a cascade of emotional arousal and associated physiological changes, allowing emotions to dissipate (Segal et al., 2002).

Mindful emotion regulation then necessitates two aspects that are distinct and separate from other cognitive emotion regulation strategies, namely: (i) perceiving all mental phenomena as mental events that need not to be altered/engaged with; and (ii) *equanimity* (non-attachment) (further elaborated in Section 1.2.4), which is staying unperturbed by the intensity and/or valence of emotional experience.

1.2.4 *Equanimity*

Equanimity refers to a *balanced* mental state towards experiences without being *consumed* by those experiences, irrespective of their underlying valence (i.e. whether positive, negative, or neutral) (Desbordes et al., 2015). Characterised by the absence of a strong attachment (i.e. identifying experiences as positive and pleasant) or dislike (i.e. identifying experiences as negative and unpleasant) towards internal and external events, a state of *equanimity* encourages the acceptance of all experiences with tenderness, warmth and empathy without 'fixating' on them (Sahdra et al., 2010). *Equanimity* is a key concept that is well-elaborated upon in traditional Buddhist texts, but it has been relatively recently introduced as a mechanism of mindful attention and emotion regulation.

As evidenced by several neurobiological and clinical studies (review, Farb et al., 2012), mindful attention to emotional experiences does not only translate to less rumination but also facilitates more positive emotions whilst reducing the development of negative ones (Guendelman et al., 2017). Consequently, this weakens the likelihood of emotional experiences being perceived as 'challenges' to overcome. Instead, the emotional experiences and reactions to them are simply observed rather than elaborated upon. This continued observation of the present-moment experiences, without judgement, reactivity or elaboration, leads to the arising of *equanimity*, an effortless stability of not being perturbed by experiences, positive or negative, whilst itself being characterised by positive feeling tone (Frances et al., 2020). As such, development of *equanimity* takes time and practice, and it is, therefore, a distinctive feature of mindful emotional regulation in expert meditators (Grecucci et al., 2015).

Equanimity promotes a quicker disengaging of attention from emotional experiences and restoration to the original baseline state (Desbordes et al., 2015). For example, a state of *equanimity* might involve quicker recovery from a startle reflex in response to a threatening loud sound, since a balanced mental state would promote less emotional impact.

1.2.5 *Non-Reactivity* and Non-Judgement

Non-reactivity is of particular relevance in the context of mindfulness as an emotion regulation strategy. It is achieved when experiences and emotions are accepted as they arise and dissolve into awareness, without automatically reacting to them or avoiding them (Iani et al., 2019; Zou et al., 2020). *Non-reactivity* towards emotions is associated with reduction in perceived stress (Benzo et al., 2018), acting as a buffer in stress reactivity, allowing the initiation of new responses and fostering cognitive flexibility (Dajani & Uddin, 2015; Zou et al., 2020). It is also associated with attenuation in mood symptoms following mindfulness training (Zou et al., 2020). *Non-reactivity* towards emotions and thoughts is therefore an effective emotion regulation strategy, diminishing emotional distress and stress reactivity (Iani et al., 2018).

Non-reactivity, along with *non-judgement,* have been found to be mediating factors in emotional well-being, both directly impacting emotional distress (Baroni et al., 2018). *Non-judgement* entails allowing experiences to arise, without categorising them as pleasant or unpleasant, likable or dislikeable, which is considered to alter an individual's habitual stress appraisal (i.e. the manner in which individuals deal with stressful events). *Non-judgement* reduces rumination and promotes dissociation from negative (critical) self-monitoring (Desrosiers et al., 2013), as well as attenuating emotional suppression (Reber, 2013).

1.3 Role of Emotion in Attentional Processing

One of the research questions explored in this thesis is the impact of meditation practices generally, and mindfulness meditation (as secularly defined) in particular, on attentional capacity in the context of emotional processing. This section thus considers the multifaceted interaction between attentional and emotional processes as well as their dynamic interplay, with a focus on *attentional capture* (Section 1.3.5). As discussed in Section 1.2, mindful awareness involves processing all stimuli without preference, elaboration, judgement, or reactivity (Bishop et al., 2004; Kabat-Zinn, 1990), improving attention regulation and promoting mental well-being via effective and efficient emotion regulation (Dunning et al., 2019; Reynolds et al., 2014).

1.3.1 Attentional Processing

Attentional processes form a complex system of interrelated, distinct mechanisms. Whilst multiple features of an attentional system are conceptually assigned specialised roles in aiding behaviour and cognition, in practice, the key components, including attentional selection, attentional engagement, and attentional control, function in a unified fashion. Overall, attentional regulation plays a role in selecting and processing information that is the most relevant and significant in a particular context. Attentional selection and control involve i) *shifting* between stimuli, responses or thoughts; ii) *adjusting* attentional selection depending on goal-directed demands; and iii) *inhibiting* attentional engagement with stimuli or mental content (e.g. thoughts) that would be considered distractors in the context of the present goal-directed demands (Eysenck et al., 2007). The self-regulatory aspect of attentional system that involves effortful control mechanisms for inhibiting stimuli or behaviours that are irrelevant to the present context is referred to as the 'executive attention system' (Petersen & Posner, 2012). The executive attention system is pivotal in enabling to override a prepotent stimuli (i.e. responding to threat) and to execute a subdominant response, such as disengaging attention from distractor stimuli and reorienting attention to relevant stimuli (Morales et al., 2016).

1.3.2 Selective Attention

Selective attention acts as a mechanism of filtering out sensory stimuli in the environment. Since attentional resources are in limit, not all incoming sensory information can be attended to for further processing, and, therefore, selectivity is essential for coherent and efficient cognitive function. Henceforth, only the most significant information as relevant to a particular context proceeds to deeper elaborative processing whilst irrelevant information is filtered out (Hansen & Hansen, 1988; Lodha & Gupta, 2023).

1.3.3 Attention Allocation

Since attention is automatically seized by the presentation of emotional stimuli, emotionally charged experiences can distract from goal-driven cognition or behaviour. As discussed in section 1.3.2, the vast amount of incoming information from a fast-changing environment requires selective attending to what is most significant and ignoring irrelevant distractors. For instance, attending to traffic signals, road signs, and other vehicles whilst driving is crucial whilst billboards and shopfronts should be ignored. This *attention allocation* towards stimuli related to the current goal-directed behaviour (i.e. driving) is referred to as *goal-driven attention* (Theeuwes, 1992). Diversion of goal-driven attention can be advantageous (i.e. when avoiding threat) but can also be harmful (i.e. leading to a car accident). Furthermore, attention allocation can be employed as a distinctive emotion regulation approach, which involves directing attention away from emotion-inducing stimuli to attenuate the impact of emotion (i.e. diverting attention from the emotion-eliciting features of a car accident that one drives past and refocusing on the road) (Greimel et al., 2020; Rock & Gutman, 1981).

1.3.4 Emotion and Attention

Emotional stimuli, particularly when negative, are given attentional prioritisation and are preferentially selected over neutral stimuli, demanding significantly higher attentional resources (Ransom et al., 2020). Emotion arrests and sustains attention (Calvo & Lang, 2004), resulting in emotional interference with attentional processes (Pandey & Gupta, 2022). Emotional *saliency* draws cognitive resources based on the emotional *value* of a stimulus. Extensive affective research shows that emotionally salient stimuli (i.e. angry or smiling expressions or images of loved ones) are preferentially perceived and remembered when attentional resources are limited (Ransom et al., 2020).

'Affect-biased attention' refers to a selective attention process where attention is allocated (and prioritised) to stimuli that are emotionally or motivationally salient. This type of selective attention process is based on engaging (orienting to) or disengaging (orienting from) relevant environmental stimuli (Vallorani et al., 2021) and plays a regulatory role prior to the occurrence of an emotionally arousing experience. In parallel with affect-biased attention, arousal-biased competition is a process where areas of the visual cortex demonstrate increased activation for emotionally salient stimuli at the expense of relatively neutral stimuli (Damaraju et al., 2009; Lee et al., 2014). Neuroimaging evidence implicates amygdala-thalamic networks in fast orientation of attention to salient locations, supporting its role in attuning to salient stimuli and inhibiting distractors (Seeley, 2019; Zhou et al., 2021). It has been suggested that biases within this system to certain categories of stimuli form the foundation of affectively biased competition (Todd et al., 2012). Increased attentional bias toward negative emotional stimuli is a marker of mood disorders, such as anxiety and post- traumatic stress disorder (Gibb et al., 2016). Given the limited nature of attentional resources, salient stimuli that capture attention also influence future behaviours, such as impeding or facilitating information processing as well as modifying memory and perception (West et al., 2009).

1.3.5 *Attentional Capture*

Attention prioritisation to emotionally salient stimuli could lead to a *capture* of attention, even when emotional stimuli are task-irrelevant (referred to as 'distractors'). In some instances, this could be harmful (i.e. higher vulnerability to developing depression and anxiety if overattentive to negative information) (Gupta et al., 2016; Kircanski et al., 2012). This type of *attentional capture* (i.e. reallocation of attention acquired by salient stimuli) makes demands on attentional resources (Devaney et al., 2021).

As discussed in Sections 1.3.3 and 1.3.4, visual attention is known to be captured by salient emotionally inducing stimuli, particularly if negatively charged (Hansen & Hansen, 1988; Ono & Taniguchi, 2017). This occurs even at the cost of motivational short-lived goals, a phenomenon known as stimulus-driven *attentional capture* (Theeuwes, 2010, 2019). *Attentional capture* refers to the reorientation of attention by a salient stimulus (Devaney et al., 2021) and can be either *spatial* or *temporal* (Theeuwes, 1992), diverting attentional processes away from a subsequent target stimulus (Kawahara & Kihara, 2011; Theeuwes, 1992). Attention being drawn to a car crash is an example of affective stimuli inducing such stimulus-driven *attentional capture* and reorienting attention away from the target stimuli/behaviour (looking at the road for safe driving). Whereas stimulus selection and prioritisation can occur through either top-down (voluntary), goal-directed responses or bottom-up (automatic) mechanisms, *attentional capture* by salient stimuli on initial stimuli presentation occurs through a bottom-up (stimulus-driven) mechanism (Ono & Taniguchi, 2017).

1.4 The *Attentional Blink* Phenomenon

The *attentional blink* (*AB*) phenomenon refers to the attentional 'blindness' towards the target stimulus (Target 2 or T2) when it is shortly preceded (≤ 500 ms) by another target stimulus (Target 1 or T1). The *AB* effect has been studied using an *AB* paradigm (described in more detail in Chapter 2, Section 2.2), which allows investigating the temporal limitations of attentional system and its capacity as well as quantifying *attentional capture*, thought to be one of the mechanisms underlying the *AB* phenomenon (Makowski et al., 2019) (see Section 1.4.4

for further detail). The *AB* effect is thought to occur due to an ongoing processing of the T1 stimulus reducing the ability to detect the T2 stimulus (Roca & Vazquez, 2020) and can be induced using both neutral stimuli (to be referred to as *Neutral Attentional Blink* (*NAB*) or emotional stimuli (to be referred to as *Emotional Attentional Blink* (*EAB*) as 'distractors' preceding the target stimuli (Section 1.4.1 for more details).

1.4.1 The *Neutral Attentional Blink* and *Emotional Attentional Blink*

The *NAB* paradigm is a typical paradigm for quantifying *AB*, which utilises neutral T1 and T2 stimuli (e.g. digits, letters, words or pictures), embedded within a Rapid Serial Visual Presentation (RSVP) stream of distractor stimuli (see Chapter 2, Section 2.2.1 and Figure 2.1 for further detail of the *AB* paradigm). The T1-T2 intervals typically vary between 200 ms and 700 ms in an *AB* paradigm, with the *AB* effect being the strongest for 200 ms – 300 ms intervals (MacLean & Arnell, 2012).

The *AB* effect has been shown to be modulated by emotion, referred to as the *Emotional Attentional Blink* (*EAB*) or *emotion-induced blindness* (Goodhew & Edwards, 2022). The *EAB* paradigm allows quantifying a combination of limited attentional capacity and cognitive resource allocation for emotional processing/regulation (Makowski et al., 2019). The *EAB* effect is increased when the emotionally salient stimuli are presented either as the distractors between the neutral T1 and T2 stimuli within the RSVP stream (review, McHugo et al., 2013; Santacroce et al., 2021, 2023) or as the T1 before either the neutral T2 (Mathewson et al., 2008; Schwabe et al., 2011) or emotional T2 (Schwabe & Wolf, 2010). Whilst the *EAB* effect is reduced when the emotionally salient stimuli are presented as T2 (e.g. Anderson, 2005; Anderson & Phelps, 2001; Schwabe et al., 2011; Schwabe & Wolf, 2010), it is increased when emotional salient stimuli are presented as T1 (Zheng et al., 2015). An increased *EAB* indicates a stronger impact of emotional stimuli, leading to stronger deficit in T2 stimuli detection (Goodhew & Edwards, 2022).

1.4.2 Theoretical Mechanisms Underlying *Attentional Blink* and its Modulation by Emotion

The *AB* effect is generally understood to be the result of two stimuli competing for limited attentional resources (Burgard & May, 2010), so that when attentional resources are directed towards registering the T1 stimulus, this temporarily 'blinks' attention, diminishing the ability to attend to the T2 stimulus and, thus, leading to it not being perceived/identified.

A number of theoretical models within the framework of limited capacity attentional system have been proposed to explain the *AB* effect. The two-stage *Attentional Capacity* (bottleneck) model has been proposed to describe the neural underpinnings of the *AB* effect (Chun & Potter, 1995). The model postulates that during the first stage of stimuli processing, the RSVP stream is examined for target-defining features. In the instance that the RSVP item features do not match the target stimuli features, RSVP item representation quickly dissociates, and the stage terminates. However, if the RSVP item features do match the target features, the target-matching item progresses to the second stage of processing for target consolidation. Due to the limited capacity of the attentional system, only one item can be attended to and processed at one time. Therefore, a second target item (T2) is not attended to or not consolidated until the 2^{nd} stage processing of the first item (T1) is completed, leading to an impairment in identifying T2 stimuli at shorter lags (Dux, 2009).

Olivers & Nieuwenhuis (2006) have postulated a similar model referred to as the *Overinvestment Hypothesis*. The *Overinvestment Hypothesis* states that investing attentional resources into detecting T1 stimulus reduces the availability of attentional resources for detecting T2 stimulus. This implies that the T2 stimulus would be identified only under the condition that the attentional resources are freed up on time for its presentation to overcome the limited processing capacity restriction (Slagter et al., 2007). Furthermore, distractor (RSVP) stimuli could contribute to this limited capacity by interfering with the consolidation process required for detecting both T1 and T2 stimuli (Jia et al., 2016; Martens & Wyble, 2010). Consequently, it has been proposed that if fewer attentional resources are allocated to T1 stimuli identification and consolidation, more resources would be available for allocating to T2 stimuli, thereby diminishing (or even abolishing) the *NAB* (Jia et al., 2016). Raymond et al (1992) proposed the *Inhibition Model (Gating) Theory* of *AB*, suggesting that *AB* is driven by an *inhibitory* mechanism disrupting the processing of T2.

Notably in relation to the known effects of meditation on increasing positive affect (e.g. Fredrickson et al., 2017), Olivers & Nieuwenhuis (2006) have also postulated the *Positive Affect Hypothesis* which complements the *Overinvestment Hypothesis* and states that positive emotion might foster increased detection of T2 stimuli. Positive affect is thought to reduce the

NAB due to increased cognitive and/or perceptual flexibility (Tan et al., 2009). Indeed, various positive-emotion evoking stimuli, such as affective images and music of positive valence have been found to attenuate the *NAB* (Langley et al., 2008; Olivers & Nieuwenhuis, 2005).

1.4.3 *Attentional Blink* and *Attentional Capture*

The *AB* and *attentional capture* were measured using different paradigms in earlier research, the impaired performance on which was found not to correlate (Kawahara & Kihara, 2011). Maki & Mebane (2006) showed that *attentional capture* could trigger *AB* using the *AB* paradigm with a salient RSVP stream distractor. However, the *attentional capture* by the distractor was found to be dependent on having shared physical features with the target stimuli, which the authors argued would make it more challenging to disengage attention from a distractor. It has also been suggested that the *AB* arises as a delay between *attentional capture* and *attentional engagement*, with the latter two being discrete stages of attentional selection (Zivony & Lamy, 2016).

Attentional capture has been postulated as the main mechanism underlying the *AB* modulation by emotion. The increased *AB* by an emotionally salient distractor ('to-be-ignored' RSVP item) presented before T1 and T2 stimuli is thought to be driven by *attentional capture* (review, McHugo et al., 2013), due to the emotional stimuli being preferentially attended to, even if task-irrelevant, requiring substantial attentional resources for processing (Vuilleumier, 2005). This puts further processing demands in addition to the demands associated with T1 stimuli processing, increasing the impairment in identifying T2 stimuli.

Similarly, the *AB* decrease by emotionally salient T2 stimuli has been explained by the automatic orientation of attention towards attention-capturing T2 stimuli due to the preferential attention to and processing of emotional stimuli, 'overriding' attentional engagement with the ongoing processing of the T1 stimuli (e.g. Mathewson et al., 2008; Schwabe et al., 2011). Therefore, the *AB* modulation by emotional stimuli in both cases is thought to be underlined by the bottom-up (saliency-driven) attentional mechanism (McHugo et al., 2013). The *AB* increase by the presentation of the emotionally salient T1 stimulus, when it is task-relevant in the context of the *AB* paradigm, is thought to occur due to the interplay between the goal-directed (top-down) and saliency-driven (bottom-up) attentional mechanisms (Mathewson et al., 2008).

Thus, the role of the *attentional capture* in the context of the *AB* effect has been demonstrated for both emotionally neutral and emotionally salient stimuli. Both semantic and perceptual processing (surface-level visual feature processing of the stimulus) appear to drive *attentional capture*, contributing to the *AB* effect. Overall, the debate as to whether the *attentional capture* is driven by bottom-up or top-down attentional processes or the interplay between the two is ongoing, with some evidence for *attentional capture* by salient stimuli being subject to top-down control (Kiss et al., 2012).

1.5 Sensory Information Processing and Sensorimotor Gating

In addition to understanding the effects of meditation more generally and mindfulness meditation specifically on attentional capacity and *attentional capture* using an *AB* framework (see Section 1.4), it aims to investigate the effects of meditation on these processes using sensorimotor 'gating' (filtering) framework. Sensorimotor gating refers to a neural process whereby a weak sensory stimulus inhibits or *gates* a motor response to a strong sensory stimulus to protect limited capacity sensory information processing system from stimuli overload whilst it processes the first (weak) sensory stimulus (Braff & Geyer, 1990). This process supports the orientation of attention towards stimuli and, therefore, is an indirect measure of cognitive resources allocation (Gonzalo et al., 2016).

1.5.1 *Prepulse Inhibition*

Sensorimotor gating has been extensively studied using the acoustic startle reflex (ASR) modulation referred to as *Prepulse Inhibition (PPI)* (Swerdlow et al., 1999), which has become established as a fundamental operational measurement of sensorimotor gating in both animal and human models (Li et al., 2009). The ASR is an automatic (reflexive) mechanism elicited in response to a sudden, loud acoustic stimulus, which functions to protect against potential threat by activating defensive behaviours (Böhmelt et al., 1999).

PPI refers to an attenuation of the startle reflex magnitude when a 'pre-stimulus' of weak, non-startling intensity *(prepulse)* precedes an intense startle stimulus *(pulse).* Stimuli can be acoustic or tactile to exert *PPI* effects (Gómez-Nieto et al., 2020; Kumari et al., 2000, 2015). *PPI* is thought to serve a key role in the suppression of possibly interfering behavioural and sensory responses and, thereby facilitating efficient information processing (Swerdlow et al., 2016). *PPI* typically occurs at *prepulse-pulse* intervals of 30-150 ms (Graham, 1975). The *PPI* paradigm as a measure of sensorimotor gating will be discussed in further detail in Chapter 2 (Section 2.3). Multiple human (review, Lei et al., 2018) and rodent (e.g. Li et al., 2008; Zou et al., 2007) studies revealed that *PPI* can be top-down modulated by higher-order cognitive processes, including spatially selective attention and fear conditioning-induced attention (Ding et al., 2020).

PPI impairments can occur when a *prepulse* fails to attenuate the startle response, which is indicative of disrupted sensory information filtering and predictive of attentional abnormalities, sensory overload, and cognitive problems (Swerdlow et al., 2016). The disruption of *PPI* has been observed in different psychopathologies, including panic disorder, post-traumatic stress disorder, schizophrenia, Tourette's syndrome, and others (Kumari et al., 2000; Li et al., 2021; Ludewig et al., 2002; Manning et al., 2021). Neurological disorders (e.g. seizures) as well as compulsions and obsessions have also reported to be a result of a defective gating mechanism, preventing the filtering of irrelevant thoughts, sensory cues or actions (Hoenig et al., 2005). The *PPI* deficit has, therefore, been proposed to present a transdiagnostic mechanism in neuropsychiatric disorders (Santos-Carrasco & De la Casa, 2023).

1.5.2 Theoretical Models of *Prepulse Inhibition*

Two *PPI* hypotheses have been proposed in relation to startle reflex modulation: (i) *Protection-of-Processing Hypothesis* and (ii) *Interruption Hypothesis* (Graham, 1975). The two hypotheses put a somewhat different emphasis on the roles of the *prepulse* and the *pulse*, as well as the processes involved. The *Protection-of-Processing Hypothesis* states that *PPI* acts to protect the processing of the *prepulse* from external interruptions, preventing the startling stimulus (*pulse*) from interfering with ongoing information processing and thereby attenuating the startle response. Two automatic mechanisms are proposed to be activated upon the presentation of a weak stimulus: one identifies the *prepulse*, whilst the other inhibits the processing of *pulse*. In accordance with this theory, the weaker *prepulse* does not only initiate information processing of itself but also engages the gating mechanism that dampen the response to the startling stimulus (*pulse*). The *Interruption Hypothesis* states that the *pulse* interrupts the ongoing cognitive processing of the *prepulse*, with *PPI* serving to 'protect' *prepulse* processing by limiting the processing of the *pulse*, resulting in attenuated startle response. Therefore, 'protection' cannot be evaluated, or possible, without 'interruption' being present (Blumenthal et al., 2015; Graham, 1975).

1.6 Affective Bias

1.6.1 *Affective Priming*

Based on the premise that cognition and behaviour are influenced by an ongoing automatic (unconscious) evaluation of the environment in term of ‘positive/negative’, ‘pleasant/unpleasant’ or ‘likable/dislikeable’ judgements (Dirk Hermans et al., 1994), automatic evaluative mechanisms enable assessment of surrounding environment without demanding abundant attentional resources (Ferguson & Zayas, 2009). The *Affective Priming (AP*) phenomenon refers to biasing of a response to/evaluation of a target stimulus (e.g. faces, objects, scenes, etc.) by presenting a *prime* of an affective nature before the target (Klauer, 1998; Musch & Klauer, 2003). The *AP* effect has been demonstrated in numerous experiments using an *AP* paradigm, described in greater detail in Chapter 2 (Section 2.4).

The quantification of the *AP* effect using an *AP* paradigm provides an index of the degree and impact of emotional arousal automatically triggered by a valent prime on the evaluation of the target (Klauer & Musch, 2003). Positive, negative, or neutral prime valence can either impede or amplify a response to the target. When the prime and target stimuli match in valence (emotionally congruent), targets will be responded to faster and more accurately relative to when the prime and target stimuli do not match in valence (emotionally incongruent). For example, the affective primes of negative valence enhance pain perception (i.e. faster responses and/or more negative evaluation of pictures depicting physical or emotional pain targets), whilst the primes of positive valence decrease pain perception (Villemure & Bushnell, 2002; Whitmarsh et al., 2013).

AP has been developed from earlier work on ‘semantic’ priming (i.e. lexical decision paradigms with target words; see review, Neely, 1991). It induces ‘automatic attitude activation’ denoting the automatic activation of associations or attitudes associated with a particular prime which trigger evaluative associations in the memory network (Fazio, 2001), e.g. ‘snake’ as a prime would automatically activate negative associations and attitudes and allow faster responding to a similarly negative target (e.g. scary) compared to a positive target word (e.g. adorable).

The *AP* effect has been investigated using visual and auditory affective stimuli, including emotional words (Yao & Wang, 2014), emotional facial expressions (Brunet, 2023), musical sounds (Ling Tay & Ng, 2019), and emotional pictures (Spruyt et al., 2002), as both primes and targets. The *AP* effect is automatic, since it has been observed for task-irrelevant primes (Greenwald et al., 1989) as well as in masked conditions (with subliminally-presented primes). *AP* magnitude is associated with higher allocation of attentional resources to primes (Sassi et al., 2014) and can be stronger when affective prime stimuli are task-relevant as compared with being task-irrelevant (Zhu & Takeda, 2023). Since attention is captured even by subliminally-presented stimuli (McCormick, 1997), it is suggested that automatic *attentional capture* contribute to priming effects (Skalska et al., 2006).

1.6.2 Theoretical Models of *Affective Priming*

Different models have been proposed to explain the *AP* phenomenon, including: (i) *Spreading Activation* theory (Neely, 1991); (ii) *Response Competition* theory (Klauer, 1998; Klinger et al., 2000). According to the *Spreading Activation* theory, the prime stimuli activate related representations in semantic memory, with the activation spreading to other associations within the semantic memory network. A congruent prime would then facilitate the response to/evaluation of a target due to the shared associative links between the two within the semantic memory network; however, a non-congruent prime would activate a mismatched trajectory within the associative semantic memory network to that of the target, slowing down the response to the target and/or biasing its evaluation (Bargh, 1992; Fazio, 2001). The *Response Competition* theory argues that the prime automatically enables the pre-activation of an evaluative response that matches the target's valence, thus potentiating response to the target (due to a response 'path' already being established), but this is not the case when the prime and the target are incongruent in valence (since prime-associated evaluation would require inhibition) (Klauer, 1998). However, research suggests that the mechanisms postulated by the *Spreading Activation* and *Response Competition* theories might simultaneously contribute to target response following a congruent prime (Eder et al., 2012).

Chapter 2 : Measuring Trait *Mindfulness*, *Equanimity, Attentional Blink, Prepulse Inhibition*, and *Affective Priming*

Having defined the constructs and introduced the frameworks of the core relevance to the research program reported in this thesis in Chapter 1, this chapter presents in greater detail the assessment of trait *mindfulness* and *equanimity* by self-report as well as the behavioural paradigms for indexing *AB* (both *NAB* and *EAB*) (see Chapter 1, Section 1.4), *PPI* (see Chapter 1, Section 1.5), and *AP* (see Chapter 1, Section 1.6) effects.

2.1 Measuring Trait *Mindfulness* and *Equanimity* by Self-Report

2.1.1 Five Facets of Trait *Mindfulness*

Trait *mindfulness*, whether dispositional or trained, can be assessed using self-report measures, with the most common one being the Five Facet Mindfulness Questionnaire (FFMQ) (Baer et al., 2006). The FFMQ was derived by applying the principle component analysis (PCA) to the responses of non-meditators (university students) to the items of five self-report measures of trait *mindfulness*: Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003), Freiburg Mindfulness Inventory (FMI, Buchheld et al., 2001), Kentucky Inventory of Mindfulness Skills (KIMS, Baer et al., 2004), Cognitive Affective Mindfulness Scale (CAMS, Feldman et al., 2004) and Mindfulness Questionnaire (MQ, Chadwick et al., 2008). The PCA yielded five factors or facets: *(1) Observing, (2) Describing, (3) Acting with Awareness, (4) Non-judging,* and *(5) Non-reactivity*. The facet *Observing* is mainly constituted by KIMS items (n = 11) with 3 FMI items. The facet *Describing* also mainly contains KIMS items (n = 8) with 2 CAMS items. The facet *Acting with Awareness* contains all of the MAAS items that have passed the PCA eigenvalue threshold (n = 11) with contributions by KIMS (n = 6), CAMS (n = 3), and FMI (n = 1). The facet *Non-judging* is mainly constituted by KIMS items (n = 9) with 2 MQ items. The facet *Non-reactivity* items are almost evenly split between MQ (n = 4) and FMI (n = 3).

The facet *Observing* taps into an ability to notice/be aware of present-moment experiences during daily actions, including sensory stimuli (e.g., auditory, visual, or olfactory) or physical sensations (e.g., eating, walking, showering). The facet *Describing* assesses the ability to articulate one's experience (e.g., sensations, emotions, thoughts, sentiments, viewpoints, and ideas). The facet *Acting with Awareness* captures the tendency to keep awareness of daily activities as well as one's thoughts, feelings, and body sensations, instead of being caught up in mind-wandering (e.g., daydreaming, fantasizing, worrying) or running on autopilot (Baer et al., 2006, 2008). The facet *Non-judging* measures the ability to accept one's experiences, emotions, and thoughts without judging them as positive/negative, pleasant/unpleasant, likable/dislikeable, reasonable/unreasonable, etc. The facet *Non-reactivity* measures the ability to be aware of thoughts, feelings or body sensations without emotionally reacting to or being overwhelmed by them. All five facets are assumed to be present dispositionally and can be developed through mindfulness practice (e.g. meditation) (Baer et al., 2006).

2.1.2 Critique of the FFMQ

Although, the self-report questionnaires comprising the FFMQ have individually demonstrated good psychometric characteristics, their diverse structure and content speak to the distinct emphasis by different researchers on what constitutes mindfulness, elucidating the lack of consensus on the definition, operationalisation, and conceptualization of mindfulness. Although, it can be argued that the FFMQ allows an assessment of mindfulness as a multifaceted construct, the construct validity of some of the self-report measures constituting the FFMQ has been questioned (e.g. Grossman & Van Dam, 2011). Thus, in the MAAS (Brown & Ryan, 2003), the items of which mainly constitute the FFMQ *Acting with Awareness* facet, utilises an approach of measuring mindfulness by its absence – that is, MAAS assesses absent-mindedness, general inattentiveness, and the tendency to run on automatic pilot. This does not, *per se*, reflect the qualities or experience of mindfulness but rather denotes self-attribution of inattentiveness (Grossman & Van Dam, 2011). Given that the tendency of mind-wandering underlying automatic pilot mode is associated with a lack of meta-awareness (e.g. Schooler, 2002), it brings to question the accuracy of assessing one's own inattentiveness in the presence of trait absentmindedness. Indeed, non-meditators (university students) were more likely to reject absent-mindedness items of the FFMQ than to endorse items that reflect the presence of mindfulness, whereas the meditators were equally likely to endorse both types of items (Van Dam et al., 2009), most likely because meditators had greater meta-awareness of the frequency of attentional lapses as experienced in daily life than non-meditators. Some findings also suggest that non-meditators and meditators have differential interpretations of the meaning of the MAAS items. Thus, a number of studies have reported no difference in the MAAS scores between non-meditators and meditators (e.g. Antonova et al., 2015; MacKillop & Anderson, 2007). Comparable MAAS scores were reported between Tai students (a population where Buddhist beliefs are predominant) and US students (where Buddhist beliefs are in the minority), even though previous experience of/exposure to meditation of the students in two countries was substantially different (Christopher et al., 2009). However, more general critique of measuring mindfulness by its absence was leveraged on the grounds that the absence of something (a medical diagnosis) does not necessitate the presence of its opposite (optimal physical health) (Grossman & Van Dam, 2011). Nevertheless, despite the critique of MAAS's theoretical approach to measuring mindfulness, as well as some of the empirical findings that cast a shadow on its construct validity, the FFMQ *Acting with Awareness* facet has expected inverse relationships with the measures of neuroticism, difficulties in emotional regulation, experiential avoidance, dissociation, absent-mindedness, and overall levels of psychological symptoms (Baer et al., 2006).

Furthermore, the FMI (Buchheld et al., 2001) which was developed to measure trait *mindfulness* in experienced meditators, has yielded the scores from binge-drinking students (Leigh et al., 2005) that were higher than the scores in experienced meditators after a meditation retreat (Buchheld et al., 2001). As with some of the MAAS findings, this suggests that the practice of meditation changes the item interpretation due to the development of the experiential understanding of mindfulness as an ability, a process, and a quality of 'resulting' awareness (see Chapter 1, Section 1.1).

The construct validity of the FFMQ itself has also raised some concerns. The facet *Observing* was unexpectedly correlated with various maladaptive constructs (including thought suppression, dissociation, absent-mindedness, and psychological symptoms) in non-meditators rather than positive, adaptive characteristics (Baer et al., 2006; Lilja et al., 2013), possibly due to the non-meditators having an observation of ongoing experiences that is self-critical. This possibility is supported by a weak negative correlation between the facets *Observing* and *Non-judging* in Baer et al (2006)'s sample (r = -.07). These findings imply that the *Observing* facet in particular might be more sensitive to meditation practice, since observing quality of mindful awareness needs to be accompanied by non-judging and *non-reactivity* for it to reflect mindful observation rather than capturing a self-critical attention towards one's thoughts and feelings.

The facet *Describing* has also been called into question as a core aspect of mindfulness (Grossman & Van Dam, 2011). The ability to describe one's experiences as a mindfulness skill has been postulated within Dialectical Behaviour Therapy (DBT; Linehan, 1993), since verbal expressiveness is often deficient in the DBT's targeted population (Borderline Personality Disorder). Baer (2011) justified the inclusion of this facet in the FFMQ as a reflection of the experience labelling or noting (e.g. labelling a thought as 'past' or 'future', naming an emotion/feeling as 'sad', 'angry', etc.), which is a technique sometimes employed in the Insight meditation tradition as an aid for the meditation novices not to get lost in thoughts and feelings. However, it is not one of the aspects of *mindful awareness* in the context of Buddhist praxis methods (Grossman & Van Dam, 2011).

Nonetheless, the FFMQ does have acceptable psychometric properties (e.g. Baer, 2009; Baer et al., 2006). The facets *Non-judging and Non-reactivity* facets are of most utility in capturing trait mindfulness by self-report since they are considered to be the core qualities of mindful awareness according to various psychological models of mindfulness (e.g. Segal et al., 2002; Shapiro et al., 2006). Non-judging and *non-reactivity* towards internal and external experiences are thought to elicit an attitude of acceptance towards present-moment experiences, which is also emphasised as one of the important qualities of mindful awareness (Lindsay & Creswell, 2017). Together with observing, they enable awareness of an individual's habitual reactions to the present-moment experiences as they arise, allowing responding to the mental events as well as external environment in an adaptive and flexible manner (Shapiro et al., 2006). Scores on *Observing, Non-judging*, and *Non-reactivity* facets, as well as the inter-correlations between them, best differentiate non-meditators and meditators (e.g. Baer, 2009; Lilja et al., 2013).

2.1.3 Measuring Trait *Equanimity*

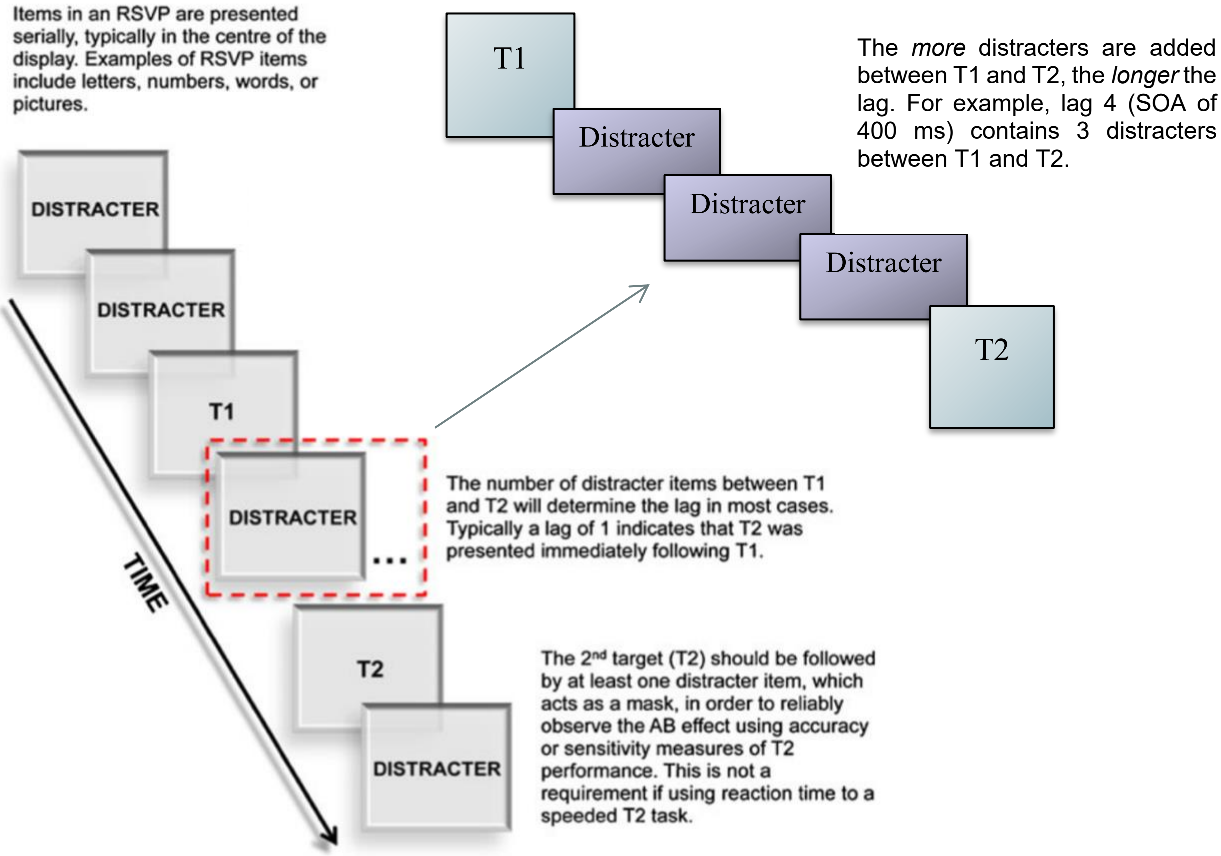
Quantifying a complex construct such as *equanimity* (subjectively or objectively) is challenging. The Non-Attachment Scale (NAS) (Sahdra et al., 2010) has been developed as a self-report measure of *equanimity* or non-attachment, which are conceptualised as synonymous by Sahdra et al (2010). Phenomenologically, an experience of non-attachment involves not clinging to (fixating upon) mental events (thoughts, feelings and body sensations) or objects of perception and not being perturbed by them (Sahdra et al., 2010). The construct of non-attachment and consequently the items of the NAS have a substantial overlap with the FFMQ facet *Non-reactivity*; however, the NAS also captures the quality of warm-heartedness as well taking joy in one's experiences ("I can enjoy pleasant experiences without needing them to last forever") and in others' achievements ("I can take joy in others' achievements without feeling envious") (Sahdra et al., 2010).

The original NAS contains 30 items (Sahdra et al., 2010). A brief version of the NAS with 7 items (NAS-7) has also been validated and found to provide similar quality of information to the NAS-30 version as well as to have reliable psychometric properties (Devine et al., 2022; Elphinstone et al., 2020).

2.2 The *Attentional Blink* Paradigm

Figure 2.1 presents a typical trial of an *AB* paradigm. Two types of *AB* paradigms were employed for research reported in this thesis (described in greater detail in Chapter 5, Section 5.2.3), which will be referred to as the *Neutral Attentional Blink* (*NAB*) and *Emotional Attentional Blink* (*EAB*) paradigms. As discussed in Chapter 1 (Section 1.4.2), the increased *AB* due to *attentional capture* is more consistently induced when either the neutral or emotionally salient stimuli have shared features (physical and/or semantic) with T2 stimuli. Therefore, the employed *NAB* paradigm uses numbers (from 1 to 9) as T1 and T2 stimuli, embedded in a stream of letters (the RSVP distractors), which are further made distinct from the RSVP distractors by colour. To make the *EAB* paradigm more comparable to the *NAB* paradigm, as well as to enhance the *EAB* effect, the present research employed a variant of the *EAB* paradigm that uses emotionally salient stimuli (words of negative valence) as T1 (rather than an RSVP distractor) with neutral T2 stimuli (words of neutral valence). This design of two paradigms taps into the interplay between the top-down (goal-directed) and bottom-up (saliency-driven) attentional mechanisms (as discussed in Chapter 1, Section 1.4.2). The common features of an *AB* paradigm are described in further detail below.

Figure 2.1 A typical Trial of an *Attentional Blink* paradigm (Adapted from MacLean & Arnell, 2012)



2.2.1 Rapid Serial Visual Presentation Stream

The *AB* paradigm is commonly employed to examine the temporal limitations of an attentional system. It is typically designed as an RSVP stream of visual stimuli (such as numbers, letters, words, or pictures) that are successively displayed for around 100 ms per item or 10 items/second, depending on the chosen stimuli and/or paradigm. In a standard *AB* paradigm, two of the stimuli presented within the RSVP stream are *targets*, with the first target stimulus referred to as 'T1' and the second target stimulus referred to as 'T2'. The remaining stimuli in the RSVP stream are referred to as *distractors* and are typically of distinct nature from the targets. For example, if the targets are numbers, the distractors would be letters. Typically, the task is to detect (presence/ absence of) and to identify the T1 and T2 stimuli (MacLean & Arnell, 2012).

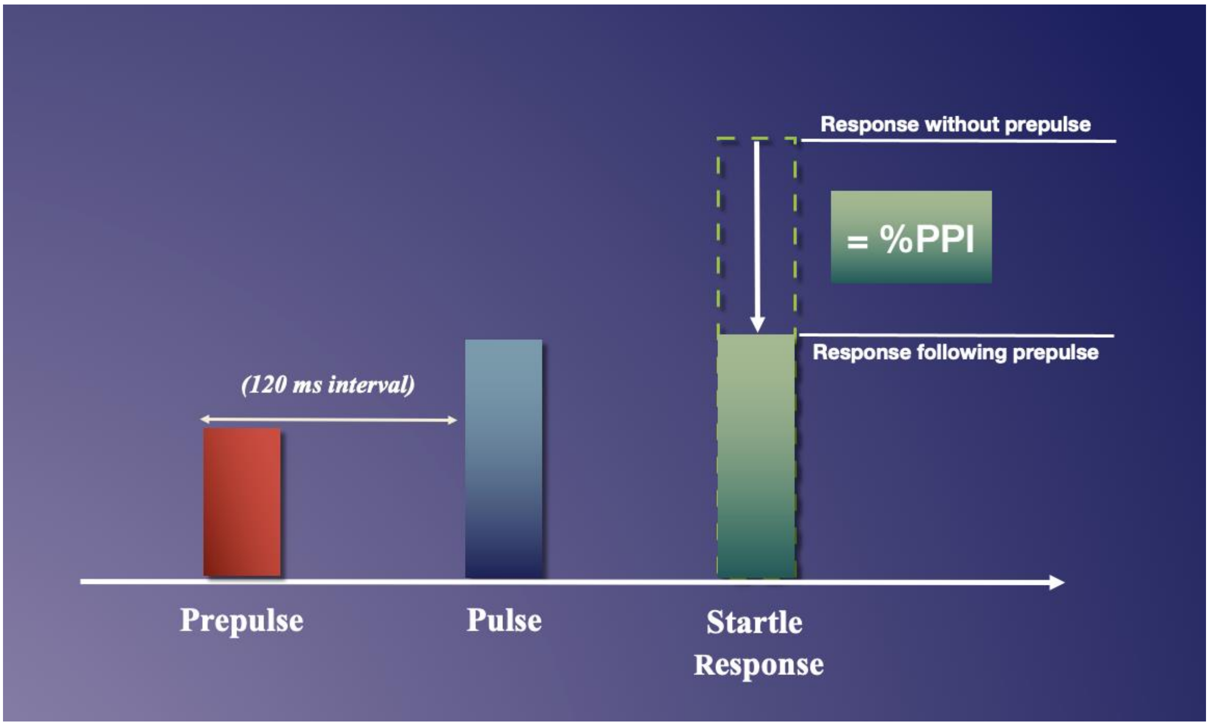
2.2.2 Lag

A *lag* is defined as the positioning of T2 stimuli relative to T1 stimuli within the RSVP stream. Lags can either be represented as the positioning of T2 stimuli following T1 stimuli, or as a time duration between T1 and T2 stimuli presentation, referred to as the stimulus onset asynchrony (SOA), with the time interval being the onset of T1 and T2 stimuli. In theory, lag 1 would thus denote that T2 immediately follows T1. With the typical presentation of the RSVP stimuli of 100 ms each, this would give an SOA of 100 ms between T1 and T2 stimuli; lag 2 would denote one distractor between T1 and T2 stimuli, with an SOA of 200 ms, and so on. A typical AB paradigm uses two target stimuli within an RSVP stream per trial, with varied lags from trial to trial. Performance is indexed using response accuracy and reaction time when identifying T2 stimuli and is normally examined as a function of lags (MacLean & Arnell, 2012).

2.3 The *Prepulse Inhibition* Paradigm

As described in Chapter 1 (Section 1.5.3), the *PPI* phenomenon occurs when a *prepulse* (a non-startling stimulus) precedes a *pulse* (a startling stimulus), leading to the attenuation of the startle reflex response. The *PPI* effect has been extensively studied using a *PPI* paradigm, where the trials containing the *pulse* only (startle-alone trials) are interleaved with trials where the *pulse* is preceded by the *prepulse* (*PPI* trials). A typical *PPI* trial is presented in Figure 2.2. The *PPI* effect is quantified by the percentage reduction in startle response amplitude from the startle-alone to *PPI* trials (Sandner & Canal, 2006), i.e. stronger startle amplitude reduction would indicate stronger *PPI* (higher *PPI* magnitude) (Figure 2.2).

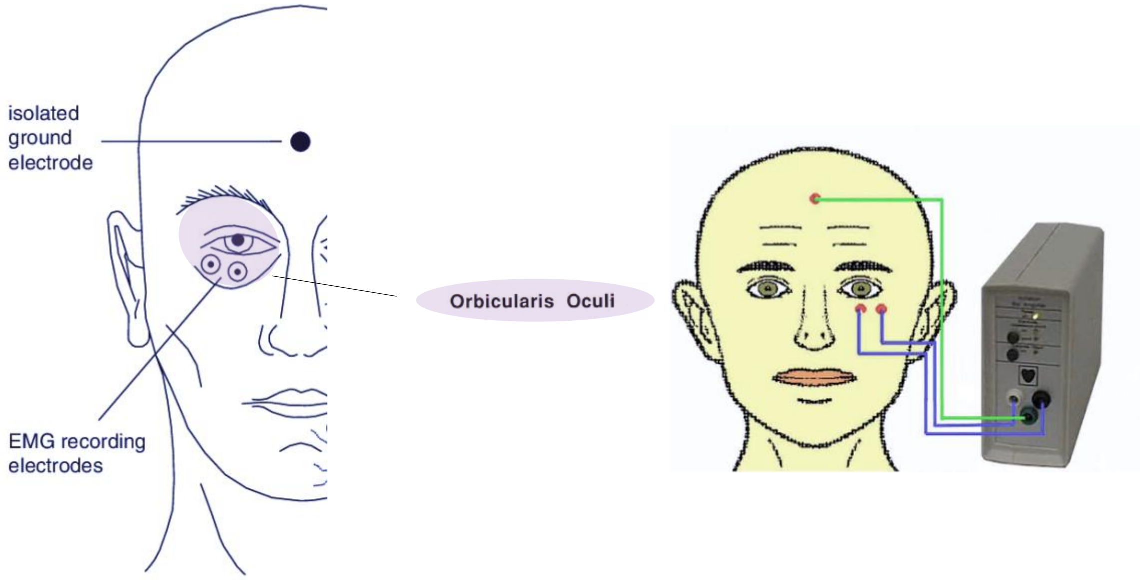
Figure 2.2. A typical trial of a *Prepulse Inhibition* paradigm



The *PPI* magnitude can be impacted by both *prepulse* and *pulse* intensity (dB noise bursts), frequency, length, as well as temporal intervals between *prepulse* and *pulse* onsets. The *prepulse-pulse* onset intervals, or stimulus onset asynchronies (SOAs), used in *PPI* research include 30 ms, 60 ms, 120 ms, 240 ms or 480ms (Blumenthal, 1996), with the most common SOAs being 30 ms, 60 ms and 120 ms. The *PPI* at shorter SOAs ($\leq$30 ms) is characterised as a pre-attentive mechanism (i.e. functioning outside of a conscious awareness) (Favero et al., 2024), as evidenced by an automatic eye-blink response (Böhmelt et al., 1999). At SOAs of 120 ms and above, attentional mechanisms have been shown to modulate *PPI*, either decreasing or increasing its magnitude (Blumenthal et al., 2015; Favero et al., 2024).

The *PPI* paradigm employed in research reported in this thesis (described in further detail in Chapter 6, Section 6.2.4) uses acoustic startling stimuli. The ASR, a rapid and automatic (involuntary) contraction of the flexor muscle (flinch) in response to startling stimuli, is measured by the electromyographic (EMG) activity (contraction) of the orbicularis oculi muscle (eye-blink muscle) (Li et al., 2009), as illustrated in Figure 2.3.

Figure 2.3. An illustration of the experimental set-up for measuring electromyographic activity (contraction) of the orbicularis oculi muscle in response to the acoustic startle.

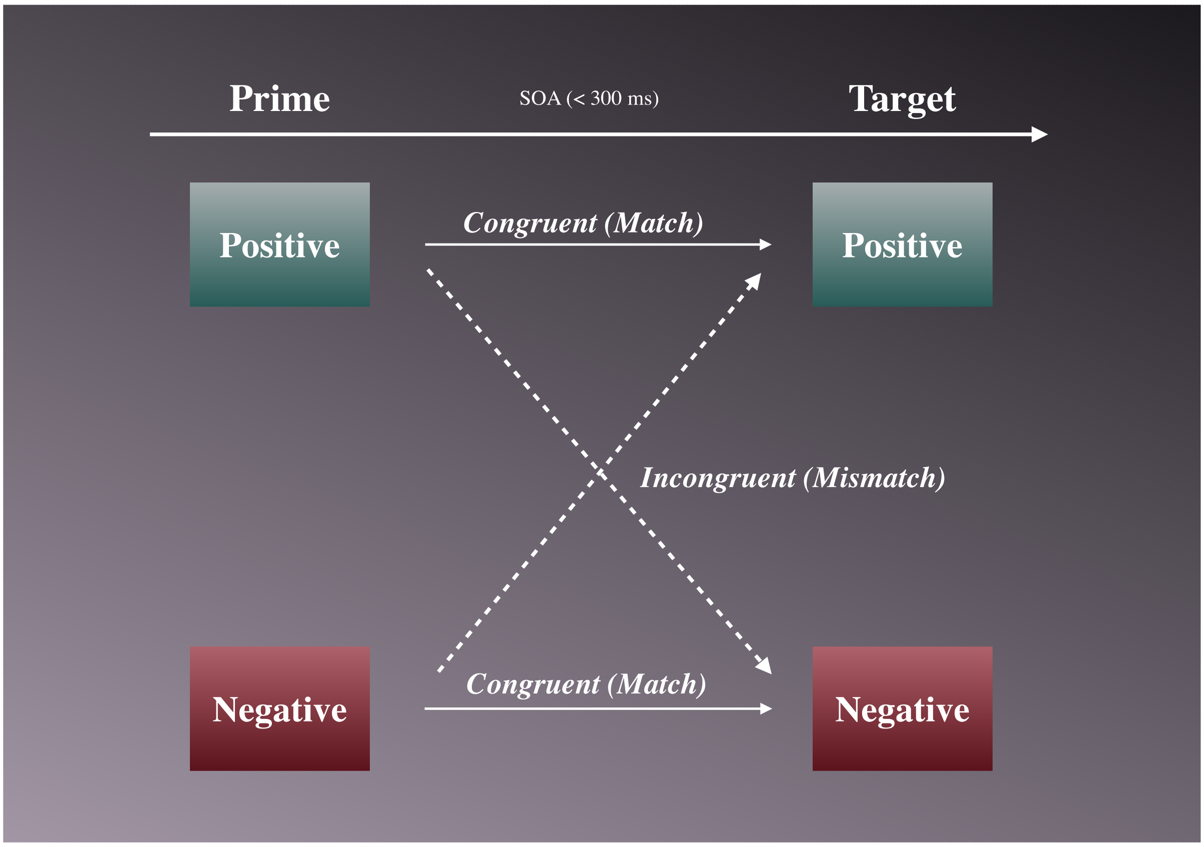


(The ground electrode in the experimental study (Chapter 6) was placed behind the ear).

2.4 The *Affective Priming* Paradigm

As described in Chapter 1 (Section 1.6), the valence of a prime preceding a target can induce a priming effect by influencing evaluative responses to the upcoming target, typically occurring for SOAs of < 300 ms from the prime onset to the target onset (Fazio et al., 1986; Jiang et al., 2016). The *AP* effect is studied using an *AP* paradigm, where primes and targets can be either *congruent* (matched in valence, e.g. positive prime/positive target) or *incongruent* (unmatched in valence, e.g. negative prime/positive target) (Wu et al., 2021). The congruent primes facilitate faster and more efficient processing and evaluation of target stimuli as compared with the incongruent ones (Fazio et al., 1986). A typical design of trials in an *AP* paradigm using congruent and incongruent primes is presented in Figure 2.4.

Figure 2.4. A typical approach to the trial design of an *Affective Priming* paradigm with congruent and incongruent conditions



Typically, in an *AP* paradigm, two affective stimuli with similar or different valence are consecutively presented. Since unconscious semantic activation by subliminal primes lasts very briefly (Greenwald et al., 1996), targets are presented and responded to within a very short response time window after target presentation for comparing response time and evaluation accuracy to the targets following congruent and incongruent primes (Fazio, 2001; Hermans et al., 2001). The *AP* magnitude can be impacted by associative strength (i.e. accessibility or impact of prime association), target location, task relevance of primes, the interval between prime and target onset as well as the type of prime and target stimuli (Hermans et al., 2001; Houwer et al., 2001). Although both words and images are utilised as prime and target stimuli, images as primes induce a stronger impact than words (e.g. Glaser, 1992; meta-analysis, Herring et al., 2013). The *AP* magnitude is present at an SOA < 300 ms from prime to target onset, with longer SOAs diminishing or even reversing the impact of the prime on a target response (Hermans et al., 2003; Klauer & Musch, 2003). Prime duration is also of importance, with subliminally-presented primes (i.e. at shorter durations under the threshold of conscious awareness) inducing stronger priming effects than longer-duration primes (Barbot & Kouider, 2012).

The *AP* paradigm employed in research reported in this thesis (described in further detail in Chapter 7, Section 7.2.3) uses subliminally-presented primes at 28 ms and 42 ms. Prime and target stimuli type are both images with strong associative strength (evoking strong emotional associations in relation to pain or no pain) and are task-relevant.

Chapter 3 : The Effects of Meditation on Mental Health, Psychological Well-Being, *Attentional Blink*, *Prepulse Inhibition* and *Affective Priming*

Having discussed the assessment of trait *mindfulness* and *equanimity* as well as the paradigms for indexing *AB*, *PPI* and *AP* effects in Chapter 2, this chapter describes the effects of meditation on mental health and psychological well-being generally, as well as on *AB* (both *NAB* and *EAB*), *PPI* and *AP* paradigm performance.

3.1 Psychological Effects on Mental Health and Well-being

3.1.1 Cognitive Effects underlying Psychological Benefits

A suggested pathway for the beneficial psychological effects of mindfulness is adaptive emotion regulation, linked to the underlying constructs of *attentional capture* and information processing mechanisms (Fuochi & Voci, 2020). Neuroimaging studies have reported improved attentional performance following meditative practices (see reviews Bondár et al., 2024; Lodha & Gupta, 2022). Enhanced attentional focus, amongst overall cognitive benefits, leads to a heightened perception of body awareness as well as improved awareness and understanding of body sensations and their link with emotions (Antoni et al., 2022), which is one of the underlying mechanisms of the effects of mindfulness on improved emotion regulation (Segal et al., 2002).

Other psychological mechanisms underlying positive effect of meditation more generally and mindfulness meditation in particular include increased cognitive flexibility and metacognitive insight as well as reduced rumination and experiential avoidance, amongst others (Shapiro et al., 2006). The freshness of experience in every moment instead of utilising past experiences to evaluate the present situation or predict probable future events, the so-called 'beginners' mind', facilitates adaptive context-appropriate responses and behaviour, rather than reactions based on habitual patterns or schemas (Bishop et al., 2004).

As discussed in Chapter 1 (Section 1.1), the mindfulness meditation approach requires a non-judgemental stance and an attitude of openness towards all present-moment experiences, including when one's attention wanders off a meditation 'task' (e.g. focus on the breath)

(Chiesa et al., 2011). This requires not engaging with the substance of thoughts and emotions but rather experiencing them without being captured by them, which leads to a reduction in repetitive (ruminative) thinking (Baer, 2009), known to be associated with mental health issues such as depression (e.g. Watkins & Teasdale, 2001).

3.1.2 Mindfulness-Based Interventions (MBIs): Effects on Psychological Health and Well-Being

Mindfulness-based interventions (MBIs) have received substantial interest from clinicians, psychologists and scientists (Virgili, 2015) and are associated with positive psychological effects, both in clinical and non-clinical contexts. MBIs are effective at decreasing stress reactivity as well as improving susceptibility to emotional distress (Keng et al., 2011). Key components of mindfulness are perceived as effective remedies against psychological distress (including anxiety, fear, anger and rumination), many of which involve maladaptive inclinations to suppress, avoid or over-engage with distressful emotions and thoughts (Kabat-Zinn, 1990).

The MBIs with the largest evidence base are Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1982) and Mindfulness-Based Cognitive Therapy (MBCT; Segal et al., 2002), followed by Acceptance and Commitment Therapy (ACT), Dialectical Behaviour Therapy (DBT), intensive short-term dynamic psychotherapy (ISTDP), and Third Wave Cognitive Therapies, such as Loving-Kindness and Compassion-based interventions (Querstret et al., 2020). Participants of MBSR and MBCT programs constitute the largest percentage of secular mindfulness practitioners who were trained in mindfulness skills in an MBI programme, either in a clinical or non-clinical context.

MBIs exert positive effects on mental health and well-being, underlined by improvements in attentional processes, emotion regulation and working memory (Zeidan et al., 2010), as well as cognitive functioning (Whitfield et al., 2022). A recent meta-analysis on MBSR and MBCT reported reduced symptoms of worry, rumination and stress, and improved quality of life in non-clinical samples (Querstret et al., 2020). Several other meta-analyses have reported a significant decrease in stress levels (Chiesa & Serretti, 2009) as well as reductions in symptoms of anxiety, depression and stress, and improved well-being (Eberth & Sedlmeier, 2012; Khoury et al., 2015; Virgili, 2015). A more recent meta-analysis highlighted the efficacy of MBIs in clinical populations, with beneficial effects post-treatment as compared with no/minimal treatment and active controls groups, further adding to their evidence base (Goldberg et al., 2018). Finally, a recent review confirmed the beneficial effects of MBIs on psychopathology, including major depressive and anxiety disorders, substance use, pain, eating disorders, PTSD and ADHD (Wielgosz et al., 2019).

The MBSR and MBCT curriculum, which has a substantial overlap, contains a number of mindfulness practices in addition to sitting meditation, including walking mindfulness, mindful movement, and informal daily mindfulness practices (e.g. mindful eating, taking a shower or brushing teeth mindfully, etc.). The focal point of all mindfulness practices within the MBSR and MBCT programmes is the development of *non-judgement* and *non-reactivity* towards all experiences (Kabat-Zinn, 2011; Segal et al., 2002). These mindfulness facets as captured by the FFMQ have been shown to be the main mechanisms underlying the effect of trait *mindfulness* on improved psychological mental health and well-being following the MBSR and MBCT participation (Medvedev et al., 2021; Zou et al., 2020). It is important to emphasise that mindfulness techniques taught within the MBSR and MBCT specifically and within the MBIs more generally are distinct from relaxation or mood management procedures, being a type of *mental training* that leads to decreased cognitive susceptibility to reactive mental states associated with affective distress that maintain psychopathology (Bishop et al., 2004).

3.2 The Effects of Meditation on *Neutral Attentional Blink* and *Emotional Attentional Blink*

As discussed in Chapter 1 (Section 1.1.5), mindfulness meditation as secularly defined promotes the development of non-fixation (i.e. not habitually fixating on incoming sensory or physical stimuli such as objects, sensations, feelings or thoughts), as well as non-judgment, *non-reactivity*, and equanimity. These effects of mindfulness practice should reduce *attentional capture* of T1 stimuli in the context of the *NAB* paradigm as well as *attentional capture* by an emotional T1 stimuli of negative valence in the context of the *EAB* paradigm, resulting in decreased *NAB* and *EAB*.

3.2.1 *Neutral Attentional Blink*

Mindfulness meditation improves attentional regulation through more effective allocation of attentional resources, as ascertained using electroencephalography (EEG) markers of attentional control (Moore et al., 2012). The effects of long-term mindfulness practice on attenuating *NAB* appear to be specific to the OM meditation style. In the study of meditation state effects, meditators had reduced *NAB* when meditating using OM relative to FA style, with this effect observed in very experienced (on average 10,000 lifetime meditation hours) but not in less experienced (on average 1300 hours) meditators (Van Vugt and Slagter, 2014). Braboszcz et al (2013) reported attenuated *NAB* effects after a 3-month Isha yoga retreat (OM-style practice), but unexpectedly, observed an increased *NAB* in experienced meditators with previous Shoonya meditation experience (FA-style practice). However, FA-style meditators (Buddhist samatha with an object, kundalini or mantra meditation) have been reported to show attenuated *NAB* as compared with non-meditators (Fabio et al., 2018). There is also evidence for the effects of meditation practice intensity. Experienced mindfulness practitioners showed improved T2 accuracy following a 3-month intensive Vipassana retreat as compared with novices, accompanied by reduced brain resource allocation to T1 measured using EEG (Slagter et al., 2007), as well as decreased cross-trial variability in theta phase synchrony for correctly identified T2 stimuli, particularly in meditators with the greatest reduction in brain resource allocation to T1 stimuli (Slagter et al., 2009). Notably, meditators who self-selected for the retreat differed greatly in the style(s) of meditation regularly practiced prior to the retreat, which were learned within different traditions (e.g., Theravada, Tibetan, or Zen), as well as prior meditation experience, with no relationship observed between prior meditation experience and *AB* task performance at baseline.

Meditation, regardless of the practice style, has been shown to have an age-related protective effect on *NAB*, with older FA- and OM-meditators (1-29 years of lifetime meditation practice) performing significantly better as compared with age-matched and younger non-meditators (Van Leeuwen et al., 2009). Negative findings have also been reported, with no differences between experienced meditators (at least 2 years of practicing mindfulness as secularly defined) and non-meditators in *NAB* performance, though meditators showed enhanced attention allocation as measured by EEG (Bailey et al., 2023). The enhancing effects of short-term mindfulness practice on *NAB* have been reported too. An 8-week mindfulness training (MT) improved T2 accuracy in meditation novices, which was correlated with improved FFMQ *Non-reactivity* facet scores (Wang et al., 2021). Sharpe et al (2021) reported higher T1 and T2 accuracy after non-meditators received either a brief FA or OM meditation induction, as compared with those that received relaxation instructions, with a small advantage for OM over FA meditation induction (effect size: 0.36). By contrast, a brief Metta (loving-kindness) meditation training (*constructive* family) did not reduce *NAB* (May et al., 2011). Overall, findings to-date tentatively suggest that *NAB* attenuation might be specific to mindfulness meditation as secularly defined (*attentional* family), with OM-style practice having a differential effect as compared with FA-style practice and other meditation approaches, in addition to being a function of practice intensity and expertise.

3.2.2 *Emotional Attentional Blink*

The studies investigating the effect of meditation on *EAB* are limited, with two studies of trained (Roca & Vazquez, 2020; Roca et al., 2023) and one study of dispositional (Makowski et al., 2019) trait *mindfulness*. Roca et al (2023) reported an attenuated *EAB* after MBSR and an 8-week Compassion Cultivation Training (CCT), with improved T1 and T2 accuracy for all emotional faces (angry, happy or neutral) in both intervention groups, but not in the no-intervention group. Similarly, Roca & Vazquez (2020) reported an attenuated *EAB* for both MBSR and CCT; however, reduced *EAB* effect was emotion type-dependent: only angry, but not neutral or happy, T1 stimuli increased T2 accuracy, with higher accuracy for positive and neutral than negative T2 stimuli. Finally, higher dispositional mindfulness as measured by the FFMQ, specifically the *Non-reacting* facet, was associated with a faster attentional disengagement from, rather than less attentional engagement with, the attention-capturing RSVP item distractors presented following T1 stimuli, as determined by a higher probability of T2 picture stimuli detection and recognition of critical distractors (Makowski et al., 2019).

3.3 The Effects of Meditation on Sensory Gating

The *PPI* paradigm is particularly well-suited for the understanding of meditation effects on sensory information processing mechanisms, such as filtering or gating. As discussed in Chapter 2 (Section 2.3), *PPI* processes at ‘short’ (< 60 ms) *prepulse-to-pulse* intervals are considered to be automatic, whereas at ‘short-to-medium’ *(60-120ms) prepulse-to-pulse* intervals, they are considered to be potentially amenable by controlled attention and conscious awareness (Dawson et al., 1997; Kumari et al., 2015). These attention-engaging intervals are also the time periods where stimulus identification and detection typically occur (Dawson et al., 1997).

Mindfulness practice should, in principle, lead to a flexible engagement in the context/task-dependent manner either of the mechanisms required for selective attention, including filtering (gating), or more open (less filtered) sensory information processing afforded by more efficient information processing and attentional/cognitive resource allocation. Therefore, theoretically, mindfulness might either enhance or attenuate *PPI*. Attenuating effects of mindfulness on the *PPI* might occur particularly at longer intervals (60-120 ms) that are above the average conscious awareness threshold and have been shown to be amenable by 'top-down' processes. There have only been a few studies using the *PPI* paradigm to examine the effects of dispositional and trained trait *mindfulness*, as well as meditation more generally, on sensory gating. Kumari and colleagues (2015) reported no differences in *PPI* between experienced meditators practicing Dzogchen or Mahamudra (Tibetan Buddhist meditation approaches most closely aligned with secular mindfulness) and non-meditators; however, the meditators performed better on verbal and visuospatial attention tasks which they had to complete concurrently with the *PPI* experiment, suggesting a greater attentional capacity. Åsli et al (2021) found no differences in *PPI* between participants who completed a short, single-session mindfulness exercise as compared with the no-intervention control group that listened to the classical music. Whilst a recent study by Kumari et al (2024) reported no *PPI* differences between meditators practicing approaches similar to secular mindfulness and non-meditators and, higher *PPI* levels were reported in a subgroup of meditators who self-reported being able to enter and sustain non-dual awareness during meditation practice as compared with those meditators who could not. However, since neither subgroup of meditators were significantly different from the non-meditator group, it is not clear whether the meditators who are able to enter and sustain the non-dual awareness have enhanced or attenuated *PPI* relative to the meditators without this ability. In addition, the study reported higher *PPI* levels in non-meditating males as compared with non-meditating females but this difference was not observed in meditators. None of the studies using the *PPI* paradigm have observed the differential effects of meditation, mindfulness or more generally, on 'short' (e.g. 30 ms) vs. medium-to-long (60 ms and 120 ms) *PPI* intervals. Given the limited research into the *PPI* effects of meditation, a careful consideration should be given to meditators' practice styles and duration, which might have an impact on the direction of the observed *PPI* effects (enhanced vs. attenuated).

3.4 The Effects of Meditation on *Affective Priming*

Since mindfulness is defined as a process of non-judgment and *non-reactivity* towards the present-moment experience (see Chapter 1, Section 1.1), in principle, higher dispositional and/or trained trait *mindfulness* should be associated with an attenuation in the *AP* effect. Experienced Zen practitioners have been shown to have faster neural processing of semantic stimuli (words) than non-meditators as measured by the Blood-Oxygenation-Level-Dependent (BOLD) response (Pagnoni et al., 2008), suggesting diminished activation of associative semantic memory networks in response to conceptually meaningful stimuli during conscious processing. In the context of the *Spreading Activation* theory (see Chapter 1, Section 1.6.1), this should attenuate the impact of the priming stimuli upon the target stimuli in the *AP* context. Furthermore, the practice of mindfulness should foster the perception of each experience (stimulus) as fresh, without attentional or interpretational bias (Pavlov et al., 2015), which in the context of the *Response-related Mechanism* theory (see Chapter 1, Section 1.6.1) should attenuate the *AP* effect. Unbiased processing afforded by mindfulness also rests on the assumption of an enhanced perception of reality 'as it is', rather then it being influenced by the self-related and worldview biases, with the studies having shown improved perceptual discrimination (MacLean & Arnell, 2010), as well as reduction in negative cognitive biases (Ford & Shook, 2019). However, it is not clear whether these effects of meditation would be evident at the level of automatic evaluative processing when the *AP* paradigm uses subliminal (below conscious awareness threshold) presentation of the priming stimuli (see Chapter 2, Section 2.4, for further detail).

No previous studies have used the typical *AP* paradigms as described in Chapter 2 (Section 2.4) to study the effects of meditation on *AP*. Two previous studies have used the *AP* effect in the context of studying meditation effects using a within-subject design that used supraliminal (consciously perceived) primes, with a brief intervention using Loving-Kindness Meditation (LKM) (Hutcherson et al., 2008; Schroter & Jansen, 2022), with the findings suggesting that meditation training can potentially improve accuracy and reaction times (RTs) during the *AP* paradigm performance. Hutcherson et al (2008) tested for implicit evaluative responses to photographs (using self, positive and neutral images, with negative and positive target words) after either a 7-min LKM or imagery intervention. Implicit responding measures unconscious activation of attitudes, biases or memory associations that require no conscious awareness. Following LKM, a more positive implicit rating of the target was found (towards the self) but this effect was not present for the imagery group. Schroter & Jansen (2022) utilised an *AP* paradigm (self, negative, and neutral pictures as primes, with negative and positive target words) as an implicit rating task, tested before and after undergoing LKM or an imagery intervention. The LKM group showed small trend-level improvements in implicit responses to all images post-intervention but showed no improvements in implicit positivity ratings. Liu et al (2021) employed a cross-modal *AP* paradigm (happy, sad and calm auditory primes matched with happy, sad and calm facial target stimuli) to assess musical emotional processing in high-trait (HT) and low-trait (LT) dispositional mindfulness groups. Two *AP* subtasks (emotional facial recognition and emotional arousal) completed during a short 10-mins mindfulness training session hearing classical sounds showed higher accuracy post-session compared with pre-session for the LT group in the facial recognition task, and faster RTs for both groups post-session compared with pre-session in the facial recognition and emotional arousal tasks. Two additional meditation studies have primarily utilised *AP* paradigms to study implicit attitudes, i.e. vegetarian preferences (Winkelmair & Jansen, 2023) or body satisfaction (Jansen et al., 2022) but have not directly examined *AP* performance between groups.

Chapter 4 : Overview of the Thesis Aims and Objectives

This chapter presents a broad outline of the thesis aims and objectives, followed by a plan of investigations and an overview of the conducted experimental studies.

4.1 Overall Aims and Objectives

Meditation enhances attentional capacity and emotion regulation; however, the underlying mechanisms driving these effects are unclear. *Attentional capture* has been suggested as one potential mechanism by which meditation practice affords more efficient attentional processes. Mindfulness mediation in particular is expected to reduce *attentional capture*. *Attentional capture*, particularly by emotionally salient stimuli, has been extensively studied using *AB* phenomenon (Chapter 1, Section 1.4). Meditators, especially those practicing open monitoring style, show reduced *AB* using the *NAB* paradigms (Chapter 3, Section 3.2). However, previous research has not studied the *NAB* and *EAB* paradigm performance within the same group of meditators to investigate whether attenuated *AB* in meditators could be underlined by the effect of meditation practice on attenuating *attentional capture*.

AB could also be underlined by an inhibitory or sensory information filtering mechanism to protect the processing of the first target, resulting in inattentive blindness towards the second target. Sensory gating (filtering) protects limited attentional system capacity from sensory information overload and has been extensively studied using the *PPI* paradigm (Chapter 2, Section 2.3). However, the relationships between *AB* and *PPI* in meditators have not been previously explored.

Meditation practice, particularly mindfulness as secularly defined, should afford unbiased information processing or at least a reduction in impact of one stimulus on the evaluation of another. Meditation practice has also been shown to reduce the activation of associative semantic memory networks in response to conceptually meaningful stimuli. The biasing (priming) of one stimulus by another has been studied using the *AP* phenomenon. Associative semantic memory networks activation, alongside *attentional capture*, has also been proposed as one of the mechanisms underlying *AP*. However, the effects of meditation practice on *AP* using the *AP* paradigm as described in Chapter 2 (Section 2.4) as well as the relationships between *AB* and *AP* paradigm performance have not been previously studied.

The main novel aims of the present thesis were, therefore, to investigate:

i) *NAB* and *EAB* and their relationship within the same group of meditators (*Study 1*);
ii) The relationships of *AB* (with the focus on *NAB*) with *PPI* (*Study 2*);
iii) The effects of meditation on *AP* as well as its relationships with *AB* (with the focus on *EAB*) (*Study 3*).

These aims were investigated cross-sectionally by comparing meditators and non-meditators.

Another novel aim across three studies was to investigate whether trait *non-reactivity* and *equanimity* underly the beneficial effects of meditation generally and mindfulness in particular on cognitive capacity and emotion regulation as indexed by *AB* (*Study 1*), *PPI* (*Study 2*), and *AP* (*Study 3*).

4.2 Plans of Investigation

This thesis contains three novel studies to address the aims and objectives.

4.2.1 Study 1 (Chapter 5): The Effects of Trait *Mindfulness* on *Neutral Attentional Blink* and *Emotional Attentional Blink*

Chapter 5 presents an online behavioural study (*Study 1*) investigating the effects of meditation on attentional capacity and emotion regulation in a sample of meditators and non-meditators as indexed by *NAB* and *EAB* using established *NAB* and *EAB* experimental paradigms, with a focus on the role of *attentional capture* as a potential mechanism underlying meditation effects on *AB*. The *NAB* quantified *AB* in a neutral context with stimuli (digits) that did not require extensive semantic processing, providing a subject-level 'baseline' in terms of *attentional capacity* in meditators and non-meditators. The *EAB* paradigm using emotional and neutral T1 stimuli quantified *EAB* in meditators and non-meditators. The relationships between *NAB* and *EAB* magnitudes were examined to ascertain to what extent *AB* might be driven by *attentional capture*. The correlations of *NAB* and *EAB* magnitudes with self-reported trait *equanimity* and *non-reactivity* investigated whether reduced *AB* in meditators is underlined by higher levels of trait *equanimity* and *non-reactivity* as the essential aspects of mindful awareness.

4.2.2 Study 2 (Chapter 6): The Relationship between *Attentional Blink* and Sensory Gating in Meditators and Non-Meditators

Chapter 6 presents a psychophysiological lab-based study (*Study 2*) investigating the relationships between *PPI* and *AB* in a separate sample of meditators and non-meditators to ascertain whether *AB* (particularly *NAB*) might be underlined by sensory gating or filtering. The relationships of *PPI* with self-reported trait *equanimity* and *non-reactivity* were explored to ascertain whether *equanimity* and *non-reactivity* developed through meditation have impact on sensory gating/filtering mechanism.

4.2.3 Study 3 (Chapter 7): *Affective Priming* in Meditators and Non-Meditators, and its Relationship with *Emotional Attentional Blink* Performance

Chapter 7 presents an online behavioural study (*Study 3*) investigating the effects of meditation on *AP* paradigm performance by comparing meditators with non-meditators, as well as the relationships of *AP* with *AB* (with the focus on *EAB*) and with trait *equanimity* and *non-reactivity,* in a *Study 1* sub-sample of participants who have completed *AP*, *NAB,* and *EAB* paradigms. The comparison of meditators and non-meditators on *AP* paradigm performance allows ascertaining the effects of meditation on affective bias during sensory information processing, whilst the investigation of the relationships between *AP* and *EAB* could indicate whether both phenomena might be underlined by *attentional capture* and/or activation of associative semantic networks. The relationships of *AP* with trait *equanimity* and *non-reactivity* could indicate whether these qualities of mindful awareness are associated with reduced affective bias during sensory information processing, possibly via attenuating effects on *attentional capture* and/or activation of associative semantic networks.

Chapter 5 (Study 1): The Effects of Trait *Mindfulness* on *Neutral Attentional Blink* and *Emotional Attentional Blink*

Chapter Overview

As discussed in Chapter 1 (Section 1.4.1) and Chapter 3 (Section 2.2), the *Attentional Blink (AB)* describes an effect of temporal attention, denoting a deficit in the processing of a second target stimulus (T2) when it is preceded by a first target stimulus (T1) within a time period of 200-500 ms (Raymond et al., 1992). As outlined in Chapter 1 (Section 1.4), *AB* can be elicited in response to a neutral T1 stimulus *(Neutral Attentional Blink; NAB)* or an emotionally salient T2 stimulus *(Emotional Attentional Blink; EAB).* In both *NAB* and *EAB*, T1 disrupts upcoming T2 target processing, resulting in an *AB* effect (Keefe et al., 2019).

Mindfulness meditation as secularly defined promotes the development of non-judgment, *non-reactivity* (Chapter 1, Section 1.2.5), and *equanimity* (Chapter 1, Section 1.2.4). Together, these effects of mindfulness practice should reduce *attentional capture* by T1 stimuli in the context of the *NAB* paradigm and emotional *attentional capture* by emotional T1 stimuli of negative valence in the context of the *EAB* paradigm, resulting in decreased *NAB* and *EAB* (Chapter 1, Section 1.4.3). Meditation suggestively enhances the rate at which attention is allocated, disengaged, and relocated, resulting in 'more efficient information processing without affecting the 'depth' (Van Leeuwen et al., 2012). The *AB* findings thus reflect greater *attentional capacity,* with meditators being more 'open' and able to readily receive and process information, as well as potentially disengage and reallocate attention from the first stimulus more rapidly to enable attentional allocation and conscious perception of the next stimulus.

The current chapter first presents a brief overview of trait *mindfulness*, followed by a brief overview of attentional and emotional processing/regulation, with the focus on *attentional capture*, before summarising the evidence from previous research on the effects of meditation and trait *mindfulness* on *NAB* and *EAB* paradigms. The study is then presented, aiming to assess *NAB and EAB* as well as their relationships with trait *equanimity* and *non-reactivity* in meditators and non-meditators.

Abstract

The human attentional system is able to handle a stream of incoming sensory stimuli, yet, has limited resources. These temporal limitations of an attentional system can be studied using *AB* phenomenon and are thought to occur due to two stimuli competing for limited attentional resources, whereby the processing of the first target stimulus (T1) reduces the ability to detect the second target stimulus (T2) if presented within 200ms - 500ms of each other. *NAB* refers to the *AB* effect induced by the neutral T1 stimuli; *EAB* refers to the *AB* effect induced by emotionally salient T1 stimuli. Mindfulness meditation attenuates *NAB* and *EAB* by increasing capacity of an otherwise limited attentional system and reducing *attentional capture* by emotional stimuli. *NAB* and *EAB* performance and its association with trait *mindfulness* (*non-reactivity*) and *equanimity* (non-attachment towards present-moment experiences) were investigated in 129 participants (Mean age: 33.92±9.99; Male/Female: 26/18), including 75 meditators (Mean age: 33.80±9.94; Male/Female: 47/28) and 54 non-meditators (Mean age: 34.09±10.15, Male/Female: 37/17), with T1-T2 intervals (lags) varying between 200ms-700ms. For *EAB* lag 200ms, female meditators had significantly higher response accuracy for both T1 and T2 stimuli when T1 stimuli was *emotional* rather than *neutral*; this effect was not observed in male meditators or for either sex in non-meditators. In mindfulness meditators, higher trait *non-reactivity* was associated with lower *NAB* at lag 500ms, and both higher trait *non-reactivity* and *equanimity* were associated with lower *EAB* at lag 300ms when T1 was *emotional.* This is the first study to show an association between smaller *EAB* and higher trait *equanimity* in mindfulness meditators, highlighting the effect of mindfulness practice on emotional regulation. Findings also suggest the differential effects of meditation on emotion regulation in females as indexed by the *EAB* effect.

5.1 Introduction

5.1.1 *Trait Mindfulness and Meditation Families*

As discussed in Chapter 1 (Section 1.1.4), trait *mindfulness* can be either dispositional (innate trait without any mindfulness practice) or trained (developed through mindfulness practice) (Rau & Williams, 2016). Trait *mindfulness* (dispositional or trained) is most commonly assessed using the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), comprising five facets: *Observing*, *Describing, Acting with Awareness, Non-judging*, and *Non-reactivity* (more details in Chapter 2, Section 2.1.1). Meditation practices have been more broadly categorised into three families, namely *attentional, constructive,* and *deconstructive* (Dahl et al., 2015). As outlined in Chapter 1 (Section 1.1.6), the *attentional* family includes focused attention (FA) and open monitoring (OM); the *constructive* family includes loving-kindness and compassion meditation (CM); the *deconstructive* family includes non-dual awareness or open presence (OP) as well as 'insight-oriented' practices, e.g., Vipassana, Sufi Muraqaba (Dahl et al., 2015). Mindfulness meditation, as secularly defined and practiced within Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) programmes, is placed within the *attentional* family of OM practice style, but it has been noted to have a similar approach to meditation as practiced within Dzogchen and Mahamudra traditions of Tibetan Buddhism (Antonova et al., 2021; Dunne, 2011), placed within the *deconstructive* family by Dahl et al (2015) (Chapter 1, Section 1.1.6).

5.1.2 *Qualities of Trait Mindfulness and Emotion Regulation*

As discussed in Chapter 1 (Section 1.2), trait *mindfulness* may afford more effective emotion regulation through maintaining mindful (i.e., non-judgmental and non-reactive) awareness of emotions with no modification, reappraisal or suppression, and regardless of their magnitude or valence (Salgó et al., 2021). Higher levels of trait *mindfulness* promote higher endurance of unpleasant emotions (Reynolds et al., 2014) and experiences (e.g., pain; Grant et al., 2011), conceptualised as a state of *equanimity* (non-attachment) (Frances et al., 2020). *Equanimity* is a non-judgemental stance and an attitude of openness towards present-moment experience, without being captured or consumed by that experience; that is, not clinging to desirable experiences or avoiding unpleasant ones (Chapter 1, Section 1.2.4). It is most closely linked with *Non-judging* and *Non-reactivity* facets of the FFMQ (Sahdra et al., 2016). As such, *equanimity* is a distinctive feature of mindful emotional regulation and is associated positively with meditation practice, fostering less biased attention (Feliu-Soler et al., 2016) (Chapter 1, Section 1.2.4)

5.1.3 *Attentional Regulation and Attentional Capture*

The impact of emotion on the allocation of attention is driven by *attentional capture* and is, therefore, a crucial area for consideration when understanding mindful emotion regulation (as described in Chapter 1, Section 1.3.5). *Attentional capture* is a reorientation of attention by a salient stimulus (Devaney et al., 2021) (more details in Chapter 1, Section 1.3.5). Since emotionally salient stimuli capture attention automatically, *attentional capture* diverts attentional processes and resources, which are limited in nature, away from a target stimulus, obstructing detection of both spatial (Folk et al., 2002) and temporal (Makowski et al., 2019) targets. The quantification of temporal *attentional capture* can be studied using the *Neutral Attentional Blink (NAB)* (Raymond et al., 1992) and *Emotional Attentional Blink (EAB)* paradigms (Keefe & Zald, 2020). The *NAB* phenomenon is a result of two stimuli competing for limited attentional resources. Processing of the first target (T1) stimulus reduces the ability to detect the second target (T2) stimulus if presented within a short timeframe following T1 (Burgard & May, 2010; Roca & Vazquez, 2020). The *AB* effect is thought to arise due to the limited capacity of attentional resources being directed towards processing the T1 stimulus, making one's attention 'blink', thus failing to detect T2 stimulus (Chapter 1, Section 1.4). The *Emotional Attentional Blink (EAB)* phenomenon, also called *emotion-induced blindness* (Keefe & Zald, 2020), signifies a momentary impaired ability to detect a target stimulus when closely preceded by an emotional distractor (McHugo et al., 2013). The emotional salience of the distractor briefly engages attention, interfering with subsequent target processing and preventing the target from being attended to and reaching awareness (Keefe et al., 2019). Consequently, this leads to an increased *AB* effect. The duration of this emotion-induced blindness is conceptualised as a combined measure of attentional efficiency and emotion regulation capacity (Makowski et al., 2019). The *EAB* is thus a 'product' of attentional and emotional capture induced by an emotionally-evocative T1 stimulus, resulting in a *lower* identification accuracy of a neutral T2 stimulus as compared to when both T1 and T2 stimuli are neutral (Schwabe et al., 2011; Schwabe & Wolf, 2010).

5.1.4 *The Effects of Meditation and Trait Mindfulness on Attentional Blink*

Mindfulness meditation improves attentional regulation through more effective allocation of attentional resources, as ascertained using electroencephalography (EEG) markers of attentional control (Moore et al., 2012). Experienced mindfulness practitioners showed improved T2 accuracy following a 3-month intensive Vipassana retreat as compared with novices, accompanied by reduced brain resource allocation to T1 measured using EEG (Slagter et al., 2007), as well as decreased cross-trial variability in theta phase synchrony for correctly identified T2 stimuli, particularly in meditators with the greatest reduction in brain resource allocation to T1 stimuli (Slagter et al., 2009). Notably, meditators who self-selected for the retreat differed greatly in the style(s) of meditation regularly practiced prior to the retreat, which were learned within different traditions (e.g., Theravada, Tibetan, or Zen), as well as prior meditation experience, with no relationship observed between prior meditation experience and *AB* task performance at baseline. In the study of meditation state effects, meditators had reduced *NAB* when meditating using OM relative to FA style, with this effect observed in very experienced (on average 10,000 lifetime meditation hours) but not in less experienced (on average 1300 hours) meditators (Van Vugt and Slagter, 2014). Braboszcz et al (2013) reported attenuated *NAB* effects after a 3-month Isha yoga retreat (OM-style practice), but unexpectedly, observed an increased *NAB* in experienced meditators with previous Shoonya meditation experience (FA-style practice). However, FA-style meditators (Buddhist samatha with an object, kundalini or mantra meditation) have also been reported to show attenuated *NAB* as compared with non-meditators (Fabio et al., 2018). Meditation, regardless of the practice style, has also been shown to have an age-related protective effect on *NAB*, with older FA- and OM-meditators (1-29 years of lifetime meditation practice) performing significantly better as compared with age-matched and younger non-meditators (Van Leeuwen et al., 2009). Negative findings have also been reported, with no differences between experienced meditators (at least 2 years of practicing mindfulness as secularly defined) and non-meditators in *NAB* performance, though meditators showed enhanced attention allocation as measured by EEG (Bailey et al., 2023). The enhancing effects of short-term mindfulness practice on *NAB* have also been observed. An 8-week mindfulness training (MT) improved T2 accuracy in meditation novices, which was correlated with improved FFMQ *Non-reactivity* facet scores (Wang et al., 2021). Sharpe et al (2021) reported higher T1 and T2 accuracy after non-meditators received either a brief FA or OM meditation induction, as compared with those that received relaxation instructions, with a small advantage for OM over FA meditation induction (effect size of 0.36). By contrast, a brief Metta (loving-kindness) meditation training (*constructive* family) did not reduce *NAB* (May et al., 2011). Overall, findings to-date tentatively suggest that *NAB* attenuation might be specific to mindfulness meditation as secularly defined (*attentional* family), with OM-style practice having a differential effect as compared with FA-style practice and other meditation approaches, in addition to being a function of practice intensity and expertise.

Comparatively, studies investigating the effect of meditation on *EAB* are limited, with two studies of trained (Roca et al., 2023; Roca & Vazquez, 2020) and one study of dispositional mindfulness (Makowski et al., 2019). Roca et al (2023) reported an attenuated *EAB* after MBSR and an 8-week Compassion Cultivation Training (CCT), with improved T1 and T2 accuracy for all emotional faces (angry, happy or neutral) in both intervention groups, but not in the no-intervention group. Similarly, Roca & Vazquez (2020) reported an attenuated *EAB* for both MBSR and CCT; however, the reduced *EAB* effect was emotion type-dependent: only angry, but not neutral or happy, T1 stimuli increased T2 accuracy, with higher accuracy for positive and neutral than negative T2 stimuli. Finally, higher dispositional mindfulness (as measured by the FFMQ), specifically the *Non-reacting* facet, was associated with a faster attentional disengagement from, rather than less attentional engagement with, negative T1 picture stimuli (critical distractors), as determined by a higher probability of T2 picture stimuli detection and recognition of critical distractors (Makowski et al., 2019).

5.1.5 *Aims and Hypotheses*

The present study extends previous research in four novel ways: (i) dispositional and trained trait *mindfulness* effects were investigated using both *NAB* and *EAB* paradigms within the same sample of meditators and non-meditators. The *NAB* quantified *AB* in a neutral context with digit stimuli (which did not require extensive semantic processing), providing a subject-level ‘baseline’ in terms of *attentional capacity* in meditators and non-meditators. The *EAB* paradigm used emotional and neutral word stimuli which quantified *EAB* in meditators and non-meditators (requiring processing of emotional information). The relationships between *NAB* and *EAB* magnitudes were therefore explored to ascertain to what extent *attentional capture* by neutral vs emotional stimuli might be associated. Both types of *AB* were also assessed in the same sample of participants for the first time, which presented an opportunity to investigate the relationships between *NAB* and *EAB* magnitudes in the same participants; (ii) mindfulness meditation as secularly defined (MaSD) vs other meditation traditions (OMT) were compared; (iii) for *EAB* paradigm, T1 stimuli were words with negative valence instead of emotional faces; and (iv) the effect of *equanimity* (non-attachment) on *EAB* performance was assessed.

The study tested the following hypotheses and predictions:

> **(H1)** Meditators would show a significantly smaller *NAB* as compared with non-meditators, with *NAB* being significantly smaller for MaSD subgroup as compared with non-meditators and OMT subgroup, at the *AB*-inducing lags of 200 ms and/or 300 ms.
>
> **(H2)** Meditators would show a significantly smaller *EAB* as compared with non-meditators, with *EAB* being significantly smaller for MaSD subgroup as compared with non-meditators and OMT subgroup, at the *AB*-inducing lags of 200 ms and/or 300 ms.
>
> **(H3)** Lower *NAB* and/or *EAB* will be significantly associated with higher *trait non-reactivity* and *equanimity* (either dispositional or trained) at the *AB*-inducing lags of 200 ms and/or 300 ms due to their expected effects on reducing *attentional capture* by T1 stimuli.

5.2 Methods

5.2.1 *Participants*

The study recruited 163 healthy participants (Mean age = 35.03 years; SD = 10.48; age range: 18-69; Male/Female: 104/59) in two groups: 95 meditators and 68 age- and sex-matched non-meditators. Opportunistic sampling via study advertisement on the TestableMinds platform was used to recruit meditators and non-meditators from the TestableMinds participant pool (n = 76 participants from the UK and n = 53 from India, with the latter due to the prevalence of meditation practice in the population; only those participants were recruited who indicated being fluent in English language). Experienced meditators were also recruited from a database maintained by author EA. The inclusion criteria for all participants were: (i) aged 18 – 70 years; (ii) fluency in English, and (iii) normal or corrected-to-normal vision. The exclusion criteria were: (i) a history of neuropsychiatric disorders; (ii) a history or current substance misuse; and

(iii) medication maintenance. An additional inclusion criterion for meditators was to be practicing meditation for at least 1 year, for at least 45 mins/day, a minimum of 5 days/week. However, meditators who completed the survey but did not meet these minimum criteria were included in the analysis.

Thirty-four participants were excluded: twelve (11 meditators, 4 non-meditators) had incomplete data or poor data quality for the *NAB* and *EAB* paradigms; six (*NAB*: 1 meditator, 3 non-meditators; *EAB*: 1 meditator, 1 non-meditator) fitted the criteria for random responding; nine (3 meditators, 6 non-meditators) due to psychotropic medication; and four meditators due to ambiguity in self-reported meditation routines.

The final analysed sample consisted of 129 participants: 75 meditators and 54 non-meditators (Table 5.1). Meditators were divided into two groups based on meditation tradition: MaSD or OMT. MaSD group included meditators practicing secular mindfulness as taught within MBSR/MBCT or within Buddhist traditions closely aligned with mindfulness as secularly defined and practiced (i.e., Dzogchen/Mahamudra of Tibetan Buddhist, Zen), as well as three meditators practicing within Vajrayana (Tibetan Buddhism) tradition who indicated their main meditation practice to be mindfulness meditation as practiced within MBSR/MBCT; OMT group included practitioners of Advaita Vedanta, Agni Yoga, Christian meditation/contemplation, Islamic (Zikr, Salah)/Sufi (Zikr, whirling) meditation, Theravada Buddhism (Vipassana/Insight), Transcendental meditation or Yoga Sutra.

5.2.2 *Design and Procedures*

A cross-sectional design was employed to test H1-H2, first with two groups (meditators vs non-meditators), and then with three groups (MaSD vs OMT vs non-meditators). A correlational design was employed to test H3 for the whole sample, meditator and non-meditator groups, and meditator subgroups (MaSD, OMT).

Demographics items and self-report measures (Chapter 5, Section 5.2.4) were administered using the Qualtrics platform. Meditators also completed the Meditation History Questionnaire (MHQ, designed by EA), which collects detailed data on meditation practice duration, practice routine, meditation tradition/style (primary and secondary), and other practice-related information (see Supplementary Materials: Appendix A, Figure A1).

The *NAB* and *EAB* paradigms were programmed in PsychoPy and administered using Pavlovia. Participants accessed the survey and paradigms via the links provided on the Testable platform or in the recruitment email. The paradigms were completed in the same order by all participants, with the *NAB* paradigm presented first, followed by the *EAB* paradigm. Breaks were provided between the *AB* paradigms.

The study was approved by the College of Health, Medicine and Life Sciences Research Ethics Committee of Brunel University London (25264-MHR-Sep/2020-27841-1). All participants provided informed consent via an online written consent form and received £20 each for their participation.

5.2.3 *Paradigms*

5.2.3.1 *Neutral Attentional Blink (NAB)*

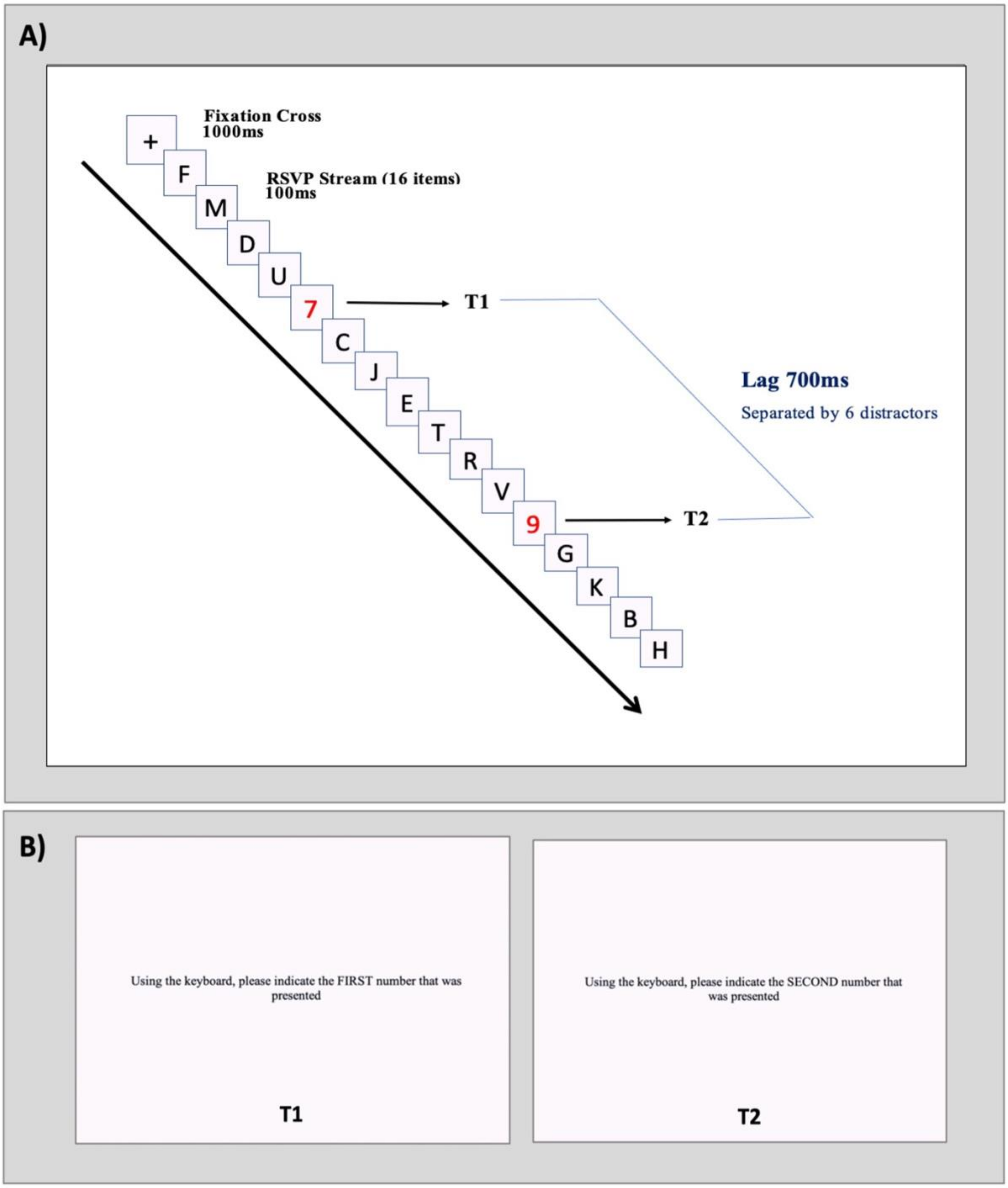
A total of 120 experimental trials were arranged in 10 blocks, with 20 trials each. T1 and T2 targets were red digits between 2-9. The Rapid Serial Visual Presentation (RSVP) stream of black letters were from the Latin alphabet, with the exclusion of I, O, Q, S, X and Z to avoid resemblance with digits.

Each trial started with a 1000ms-fixation cross, followed by a 100ms-presentation of 16 stimuli, i.e., T1 and T2 digits embedded within a RSVP stream of 14 letters. The targets were separated by lag intervals of 200 ms, 300 ms, 400 ms, 500 ms or 700 ms. To prevent T2 position learning within the RSVP stream, T2 was placed at either 3rd or 5th position from the end of the trials. Figure 5.1A presents a *NAB* paradigm trial example.

All stimuli were presented at the centre of the screen on a light background (1.000, 0.875, 0.898) with a window size of 1280 x 720 pixels. Participants identified T1 and T2 by entering a digit between 2-9 separately for T1 and T2 on two consecutive response screens, presented straight after each trial (Figure 5.1B). If uncertain of a correct response, participants were encouraged to make their best guess.

The paradigm started with three practice trials (with feedback on T1 and T2 response accuracy), followed by the experimental trials (no feedback) presented in a pseudorandomised order held constant across the participants. Lag conditions (40 trials/lag) were counterbalanced across the blocks. An optional break was offered between each experimental block. The experiment lasted approximately 16 minutes.

Figure 5.1 The *Neutral Attentional Blink (NAB)* Paradigm



A) A trial example with each trial consisting of 16 items: two red digits (T1 and T2 targets) ranging between 2-9, displayed within a rapid serial visual presentation (RSVP) stream of 14 black letters, selected from the Latin alphabet (excluding the letters I, O, Q, S, X and Z to ensure that letters that could resemble digits were not presented). A fixation cross was presented at the centre of the screen for 1000ms, followed by a 100ms presentation per item (letter or digit). T1 and T2 targets were separated by intervening 'distractors' in intervals of 200 ms, 300 ms, 400 ms, 500 ms and 700 ms from T1-to-T2 onset (lag 700ms trial presented). T2 was placed at either 3rd or 5th position from the end of the RSVP stream to prevent the learning of T2 position within the RSVP stream. **B)** The participants identified the T1 and T2 target stimuli using separate response screens presented straight after each trial.

5.2.3.2 *Emotional Attentional Blink (EAB)*

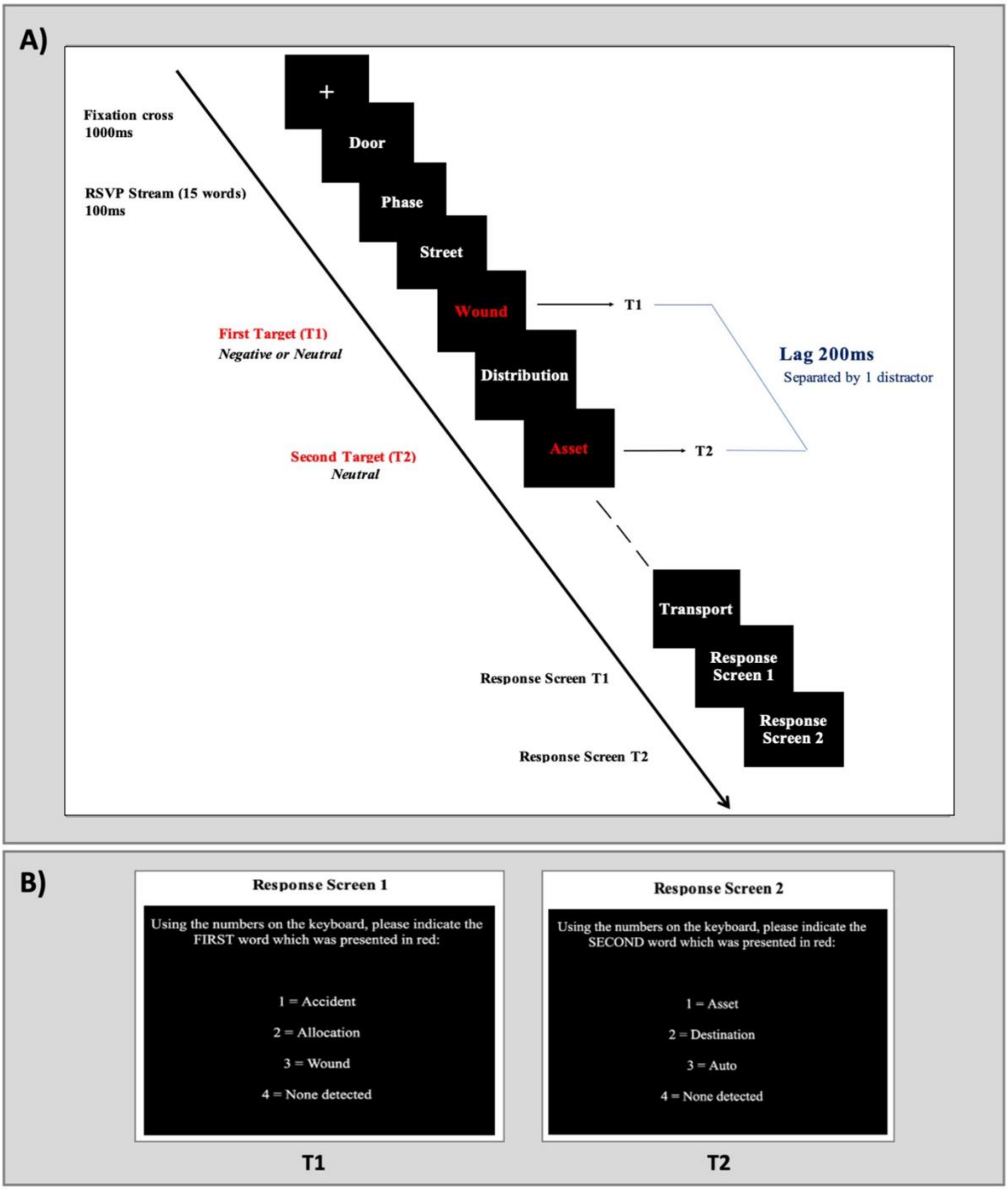
A total of 128 trials were arranged in 4 blocks, with 32 trials per block. There were two salience-based conditions: *neutral* and *emotional*. For the *neutral* condition, both T1 and T2 stimuli were *neutral* words *(T1 Neutral-T2 Neutral* trials*)*. For the *emotional* condition, T1 stimuli were emotionally-evocative words of *negative* valence, whilst T2 stimuli were *neutral* words *(T1 Negative-T2 Neutral* trials*)*. *Neutral* and *negative* words used as T1 (16 each) and T2 (32 *neutral*) stimuli were chosen from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999) and Schwabe et al (2011) libraries, based on normative ratings of emotional valence and mean arousal with the selected *negative* words having the highest mean arousal ratings. For the RSVP distractor words, 13 *neutral* words were selected.

Each trial started with a 1000ms-fixation cross, followed by a 100ms-presentation of 15 words, i.e., T1 and T2 stimuli embedded within a RSVP stream of 13 *neutral* words. The targets were separated by the intervals of 200 ms, 300 ms, 500 ms or 700 ms, with 8 trial types in total: 4 *lags* (200 ms, 300 ms, 500 ms, 700 ms) x 2 *conditions* (*T1 Neutral-T2 Neutral* trials*, T1 Negative-T2 Neutral* trials). There were 8 trials per block for each lag: 4 *T1 Neutral-T2 Neutral* and 4 *T1 Negative-T2 Neutral* trial types. In total, there were 32 trials for each lag: 16 *T1 Neutral-T2 Neutral* and 16 *T1 Negative-T2 Neutral* trial types. T2 was placed at either 3rd or 5th position from the end of the trials. Figure 5.2A presents an *EAB* paradigm trial example.

All stimuli were presented at the centre of the screen on a black background (-1.000, -1.000, -1.000) with a window size of 1280 x 720 pixels. T1 and T2 stimuli were red; RSVP stimuli were white. Participants identified T1 and T2 using numbers 1-4 on a computer keyboard, choosing from the four options (self-paced) presented separately for T1 and T2 straight after each trial: the T1/T2 target word and two incorrect words (the presentation position of the correct vs incorrect options was counterbalanced across the trials), with the fourth option always being ‘No word detected’ (Figure 5.2B). The incorrect response options (124 words in total) were either *neutral* or *negative*, depending on the trial type. If uncertain of a correct response, participants were encouraged to make their best guess.

The paradigm started with three practice trials (with feedback on T1 and T2 response accuracy), followed by the experimental trials (no feedback) presented in a pseudorandomised order held constant across the participants. The experimental trial types (lag by condition) were fully counterbalanced across the blocks. An optional break was offered between each experimental block. The experiment lasted approximately 12 minutes.

Figure 5.2. The *Emotional Attentional Blink (EAB)* Paradigm



A) A trial example with each trial consisting of 16 items: two red target words (T1 and T2), displayed within a rapid serial visual presentation (RSVP) stream of white distractor words. A fixation cross was presented at the centre of the screen for 1000 ms, followed by a 100-ms presentation per word. T1 and T2 targets were separated by intervening 'distractors' in intervals of 200 ms, 300 ms, 500 ms and 700 ms from T1-to-T2 onset (lag 200 ms trial presented). The T1 target word was either neutral (Neutral) or emotionally evocative with negative valence (Negative); the T2 target word was always neutral. T2 was placed at either 3rd or 5th position from the end of the RSVP stream to prevent learning of T2 position within the RSVP stream. **B)** The participants identified the T1 and T2 target stimuli using separate response screens presented straight after each trial, by selecting numbers 1-3 for identified word options, or number 4 for non-identified words.

For both *NAB* and *EAB* paradigms, the lags of 200 ms and/or 300 ms were *AB*-inducing intervals where the meditation effect was expected to be observed. The lags of 400 ms (*NAB* only) and 500 ms (*NAB* and *EAB*) were expected to be *AB*-inducing but not to differentiate meditators and non-meditators. The lag of 700 ms was included as the control lag: it was not expected to induce *AB* in either meditators or non-meditators, but used to ascertain that the reduction in T2 accuracy at the *AB*-inducing lags could not be explained by the working memory demands when identifying T1 and T2 stimuli from the options presented on the response screens after each trial.

5.2.4 *Self-Report Measures*

5.2.4.1 *Trait Mindfulness and Equanimity*

Trait *mindfulness* was assessed using the 39-item Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), assessing five facets: *Observing, Describing, Acting with Awareness, Non-judging, and Non-reactivity*. Participants responded using a 5-point Likert scale ranging from 1 ('*never or rarely true*') to 5 ('*very often or always true*'). Total FFMQ score was calculated by the sum of all subscales, excluding *Observing* since the inclusion of this facet would impact the validity of the total score in non-meditators, as the scores on *Observing* and *Non-judging* facets have been found to be inversely correlated in non-meditators (Baer et al., 2006), but not in meditators (Baer et al., 2009), suggesting mindful observing as a trait requires development using mindfulness practice (see Section 2.1.2 for further details). Higher total and facet scores index higher levels of trait *mindfulness* (Baer et al., 2006, 2008). The FFMQ has been reported to have high internal consistency (Cronbach's alpha, α = .87; Fogarty et al., 2015). The internal consistency in the present sample for *Observing, Describing, Acting with Awareness, Non-Judging, and Non-Reactivity* were .85, .89, .88, .91, and .83, respectively. The FFMQ subscales showed positive correlations with the total FFMQ, all significant associations between r = .53 –.80 (all p <.001), indicating good validity of the FFMQ scale and a positive relationship between total FFMQ and FFMQ subscales.

Equanimity was assessed using the 7-item Non-Attachment Scale (NAS-7; Sahdra et al., 2016). Participants responded using a 6-point Likert scale, ranging from score 1 ('*disagree strongly*') to 6 ('*agree strongly*'). A higher total score indicates higher level of trait *equanimity*. The NAS-7 has a good internal consistency with Cronbach's α of .81 (Elphinstone, Whitehead, et al., 2020), with Cronbach's α of .83 in the current sample. The NAS-7 items showed strong validity with the total NAS-7 (r = .62 - .82, all p <.001), indicating that the total NAS-7 accurately represented the NAS-7 items.

5.2.4.2 *Self-Report Data Reliability*

Two check items were embedded within the FFMQ by repeating items 7 and 29 for the identification of random responders. 'Total Same %' variable was calculated to examine deviations of >2 scores across the responses to two original items and their repetition (i.e. to check scoring similarity and consistency). If catch item scores differed by >2 scores on both check items, random responding was assumed to be present.

5.2.5 *Statistical Analysis*

Statistical analyses were conducted using SPSS Software, version 29.0 (SPSS Inc., Chicago, IL), with the *alpha* level of 0.05 for significance testing.

For both *AB* paradigms, response accuracy (RA, a total score of all correct trials) and reaction time (RT, the average RT of all the correctly identified trials) were calculated separately for T1 and T2 per lag. RA and RT for T2 was only calculated for trials where T1 was accurately identified (Raymond et al., 1992). *AB* magnitude (*%AB*) per lag was quantified using the following formula (higher *%AB* denotes a stronger *AB* effect):

$$\%\ Attentional\ Blink\ (AB) = \left(\frac{Response\ Accuracy\ (T1) - Response\ Accuracy\ (T2)}{Response\ Accuracy\ (T1)}\right) x\ 100$$

The normality of *NAB* and *EAB* data distribution was tested using the Shapiro-Wilk test. Boxplots were used for identifying outliers and random responders. T1 average accuracy scores across all trials of <50% (scoring below 20/40 for *NAB)* and <25% (4/16 for *EAB*) were used as criteria for outliers. Random responders were identified based on T1 performance, with participants scoring in the lower quartile range across all lags, i.e., 0-10 correct responses (out of 40 maximum) for the *NAB* and 0-4 correct responses (out of 16 maximum) for the *EAB,* excluded from analyses. Additionally, T1 and T2 trials with excessive RTs were excluded from analysis for the retained participants. Self-reported meditation experience data were closely examined for any inconsistencies.

5.2.5.1 *Sample Characteristics*

Group x Sex differences in age and self-report measures of trait *mindfulness* and *equanimity* were assessed using a univariate Analysis of Variance (ANOVA) model for meditator vs non-meditator groups, and a separate ANOVA for Meditation Tradition (MT) groups: MaSD and OMT (to be referred to as GroupMT throughout the Results section). The analyses for the self-report measures were re-run covarying for age as there was a significant sex differences in age (see Results), with females being older than males in both meditator and non-meditator groups.

5.2.5.2 *NAB and EAB Paradigms*

To test H1, a repeated measures ANOVA (rmANOVA) was performed to examine differences between meditators and non-meditators in *NAB* paradigm performance, with 2 (Target Position: T1, T2) x 5 (Lag: 200 ms, 300 ms, 400 ms, 500 ms, 700 ms) x 2 groups (Group: Meditator, Non-meditator) x 2 (Sex: Male, Female), with Target Position and Lag as within-subject factors, and Group and Sex as between-subject factors. A further rmANOVA was run with 3 groups (GroupMT: MaSD, OMT, Non-meditator). The predicted effect of meditation on *NAB* would be indicated by a significant Target Position x Lag x Group (meditators vs. non-meditators) and/or a significant Target Position x Lag x GroupMT (non-meditators vs. MaSD vs. OMT) interactions.

To test H2, the *EAB* paradigm performance was examined with a 2 (Target Position: T1, T2) x 2 (Condition: Neutral, Emotional) x 4 (Lag: 200 ms, 300 ms, 500 ms, 700 ms) x 2 (Group: Meditator, Non-meditator) x 2 (Sex: Male, Female) rmANOVA, with Target Position, Condition and Lag as within-subject factors, and Group and Sex as between-subject factors. A further rmANOVA was run with 3 groups (GroupMT: MaSD, OMT, Non-meditator). The predicted effect of meditation on *EAB* would be indicated by a significant Target Position x Condition x Lag x Group (meditators vs. non-meditators) and/or a significant Target Position x Condition x Lag x GroupMT (non-meditators vs. MaSD vs. OMT) interactions.

Any significant main effects and interactions involving Sex were checked for the possible effects of age using ANCOVAs with age as a co-variate. All rmANOVAs were initially run with Country (UK, India) as an additional between-subject factor but since no main effects or interactions were found for Country, it was excluded from rmANOVAs to increase power. All rmANOVAs were run for RA and RT. The Greenhouse-Geisser corrected statistics were reported where the Mauchley's test of sphericity was significant. Effect sizes, where reported, were partial eta squared (η_p^2).

All significant main effects and interactions were followed up with lower-level rmANOVAs and between- and/or within-subject pair-wise comparisons, as relevant. The *alpha* level for the planned lower-level rmANOVAs and pair-wise comparisons to further investigate significant interactions as per H1/H2 testing (i.e. involving Group at lags 200ms and/or 300ms) was maintained at .05 (p <.05) to avoid committing Type II error. The alpha level for the post-hoc analyses of the interactions that were not predicted (e.g. involving Sex but not Group) was set at .01 (p <. 01) to adjust for multiple tests to minimise committing Type I error.

The relationship between *%NAB* and *%EAB* was explored using Spearman's Rho correlation coefficients (Supplementary Materials, Appendix A, Table A4). The *alpha* level for the correlations was set to .001 (p < .001) to adjust for multiple tests.

5.2.5.3 *Relationships of NAB and EAB Performance with Trait Mindfulness and Equanimity*

To test H3, Spearman's Rho correlation coefficients (*%AB* data were not normally distributed) were used to examine the relationship of *%NAB* and *%EAB* with trait *mindfulness* (FFMQ total/facet scores) and *equanimity* (NAS-7 scores) in the whole sample, meditator and non-meditator groups, and meditation subgroups (MaSD, OMT). The *alpha* level for the correlations as per H3-testing (*%NAB/EAB* for *AB*-inducing lags with FFMQ *Non-reactivity* and NAS-7 scores) was maintained at .05 (p < .05) to avoid committing Type II error. The *alpha* level for the correlations that were exploratory/not predicted (i.e. *%NAB/EAB* at all lags with FFMQ total and *Observing, Describing, Acting with Awareness, Non-judging* scores) was set at .01 (p <. 01) to adjust for multiple tests to minimise committing Type I error.

5.3 Results

5.3.1 *Sample Characteristics*

5.3.1.1 *Meditator vs Non-meditator Groups*

Meditator and non-meditator groups did not differ on male/female ratio [$\chi^2_1 = .47$, $p = .49$], but females were significantly older than males [$F_{1, 125} = 5.01$, $p = .03$] (no additional Group effects or Group x Sex interactions) (Table 5.1).

The main effect of Group was significant for NAS-7 scores [$F_{1, 124} = 4.17$, $p = .04$], with higher trait *equanimity* scores in meditators compared with non-meditators (Table 5.1). For FFMQ *total* scores (without *Observing*), there was a main effect of Group [$F_{1, 124} = 4.66$, $p = .03$], with meditators scoring higher on trait *mindfulness* than non-meditators. There was also a main effect of Sex [$F_{1, 124} = 5.71$, $p = .018$] and Group x Sex interaction [$F_{1, 124} = 4.87$, $p = .03$], with male non-meditators scoring significantly higher than female non-meditators. For FFMQ *Describing* scores, there was a significant main effect of Group with higher scores for meditators than non-meditators [$F_{1, 124} = 4.09$, $p = .045$], and a significant Group x Sex interaction [$F_{1, 124} = 8.57$, $p = .004$], with female meditators scoring higher than male meditators, and male non-meditators scoring higher than female non-meditators. For FFMQ *Acting with Awareness* scores, there was a significant Sex effect [$F_{1, 124} = 10.33$, $p = .002$], with males scoring significantly higher than females in both meditator and non-meditator groups. There were no Group effects or Group x Sex interactions for *Observing, Non-judging,* or *Non-reactivity* scores (Table 5.1).

5.3.1.2 *MaSD vs OMT vs Non-meditators*

The main effect of Sex for age was significant [$F_{1, 123} = 5.18$, $p = .03$]. Post-hoc independent samples *t*-tests showed that female MaSD meditators were significantly older than male MaSD meditators [$t_{43} = -2.91$, $p = .006$] (Table 5.2). Meditator subgroups did not differ on male/female ratio [$\chi^2_2 = .63$, $p = .73$].

There were significant main effects of Meditation Tradition for FFMQ *total* (without *Observing*) [$F_{2,122} = 4.67$, $p = .01$] and *Non-judging* [$F_{2,122} = 4.66$, $p = .01$] scores, with MaSD meditators scoring higher than both OMT meditators [FFMQ *total*: $t_{73} = 2.64$, $p = .01$; *Non-judging:* $t_{73} = 3.37$, $p = .001$] and non-meditators [FFMQ *total*: $t_{97} = -2.26$, $p = .03$; *Non-*

judging: t_{97} = -2.23, p = .03] (Table 5.2). There was a significant GroupMT x Sex interaction for FFMQ *Describing* scores [$F_{2,122}$ = 4.39, p = .01]. Follow up lower-level ANOVAs showed the interaction to be present in both groups: male non-meditators scored higher than female non-meditators, whilst MaSD female meditators scored higher than MaSD male meditators [$F_{1,94}$= 6.45, p = .01] and OMT female meditators scored higher than OMT male meditators [$F_{1,79}$= 4.69, p = .03]. For FFMQ *Acting with Awareness* scores, there was a main effect of Sex [$F_{1,122}$= 7.47, p = .007], with follow-up independent samples *t*-test showing that male non-meditators scored higher than female non-meditators [t_{52} = 2.66, p = .01]. There were no main GroupMT effects or GroupMT x Sex interactions for FFMQ *Observing*, *Non-reactivity* or NAS-7 scores (Table 5.2).

5.3.2 *Meditation Practice Indices*

Meditators were characterised by three meditation indices: Total Years of Regular Meditation (YoP, as self-reported by the participants); Total Hours of Regular Practice (HoP, calculated using self-reported daily meditation routine with and without practice hours accumulated in teacher- and/or self-led meditation retreats); and Intensity of Regular Practice (IoP, calculated as HoP – (YoP x 365) with values equal to or below zero indexing moderate practice routine and values above zero indexing intensive practice routine based on the arbitrary assumption of more than one hour per day each day being an intensive practice; Antonova et al., 2015). MaSD and OMT groups did not significantly differ on any indices (Table 5.3).

Table 5.1. Demographic characteristics and self-reported trait *mindfulness* and *equanimity* for the whole sample as well as for Meditator and Non-meditator groups.

Demographics	**Whole Sample (N = 129)**		**Meditators (N = 75)**		**Non-meditators (N = 54)**		**Group Difference**
Sex							$\chi^2_{(1)}$ (*p*-value)
Male	84		47		37		.47 (.49)
Female	45		28		17		
Age	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	$F_{1,125}$ (*p*-value)
Male	32.40 (8.86)	18-62	31.85 (8.97)	18-58	33.11 (8.79)	18-62	
Female	36.76 (11.38)	19-69	37.07 (10.76)	20-69	36.24 (12.67)	19-65	.32 (.58)
Total	33.92 (9.99)	18-69	33.80 (9.94)	18-69	34.09 (10.15)	18-65	
Self-Report Measures	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	$F_{1,124}$ (*p*-value)
NAS-7 Equanimity							
Male	30.89 (6.26)	7-42	31.36 (6.08)	14-42	30.30 (6.51)	7-41	
Female	29.91 (7.56)	11-42	31.43 (6.97)	15-42	27.41 (8.05)	11-39	1.20 (.28)
Total	30.55 (6.73)	7-42	31.39 (6.38)	14-42	29.39 (7.09)	7-41	
Total FFMQ (Without Observing)							
Male	104.43 (19.14)	50-140	104.26 (17.74)	71-140	104.65 (21.04)	50-140	
Female	98.20 (20.84)	49-143	104.29 (19.33)	52-143	88.18 (19.80)	49-120	4.87 **(.03)**
Total	126.66 (21.54)	61-180	129.27 (20.81)	61-180	123.04 (22.20)	70-159	
FFMQ Observing							
Male	23.79 (6.43)	10-40	23.91 (6.12)	10-35	23.62 (6.88)	13-40	
Female	25.56 (7.28)	8-37	26.82 (7.53)	9-37	23.47 (6.52)	8-33	1.43 (.23)
Total	24.40 (6.76)	8-40	25.00 (6.78)	9-37	23.57 (6.71)	8-40	
FFMQ Describing							
Male	26.15 (7.23)	9-40	25.62 (6.85)	12-40	26.84 (7.73)	9-40	
Female	26.18 (7.30)	9-37	28.68 (6.03)	16-37	22.06 (7.50)	9-36	8.57 **(.004)**
Total	26.16 (7.23)	9-40	26.76 (6.68)	12-40	25.33 (7.92)	9-40	
FFMQ Acting with Awareness							
Male	29.05 (6.49)	13-40	29.17 (6.08)	16-40	28.89 (7.07)	13-40	
Female	25.62 (6.71)	8-40	26.86 (6.81)	8-40	23.59 (6.21)	11-34	1.34 (.25)
Total	27.85 (6.75)	8-40	28.31 (6.42)	8-40	27.22 (7.19)	11-40	
FFMQ Non-Judging							
Male	27.64 (7.21)	8-40	27.47 (7.49)	13-40	27.86 (6.94)	8-38	
Female	25.73 (8.16)	8-40	27.32 (7.85)	11-40	23.12 (8.22)	8-39	2.47 (.12)
Total	26.98 (7.58)	8-40	27.41 (7.58)	11-40	26.37 (7.62)	8-39	
FFMQ Non-Reactivity							
Male	21.58 (4.86)	9-35	22.00 (5.01)	9-32	21.05 (4.67)	10-35	
Female	20.67 (5.88)	8-34	21.43 (5.80)	11-34	19.41 (5.97)	8-28	.25 (.62)
Total	21.26 (5.23)	8-35	21.79 (5.29)	9-34	20.54 (5.11)	8-35	

Table 5.2. Demographic characteristics and self-reported trait *mindfulness* and *equanimity* for Non-meditator group and Meditation Tradition subgroups: Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT).

Demographics	**Non-meditators (N = 54)**		**MaSD (N = 45)**		**OMT (N = 30)**		**Group Difference**
Sex							$\chi^2_{(2)}$ (p-value)
Male	37		29		18		.63 (.73)
Female	17		16		12		
Age	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	$F_{2,123}$ (p-value)
Male	33.11 (8.79)	18-62	32.34 (8.79)	18-51	31.06 (9.45)	21-58	
Female	36.24 (12.67)	19-65	41.19 (11.35)	28-69	31.58 (7.13)	20-44	1.76 (.18)
Total	34.09 (10.15)	18-65	35.49 (10.56)	18-69	31.27 (8.47)	20-58	
Self-Report Measures	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	$F_{2,122}$ (p-value)
NAS-7 Equanimity							
Male	30.30 (6.51)	7-41	32.83 (5.50)	21-42	29.00 (6.37)	14-42	
Female	27.41 (8.05)	11-39	31.25 (7.11)	15-42	31.67 (7.08)	20-42	1.88 (.16)
Total	29.39 (7.09)	7-41	32.27 (6.09)	15-42	30.07 (6.67)	14-42	
Total FFMQ (Without Observing)							
Male	104.65 (21.04)	50-140	108.59 (17.87)	71-140	97.28 (15.56)	76-127	
Female	88.18 (19.80)	49-120	108.69 (17.79)	84-143	98.42 (20.50)	52-124	2.71 (.07)
Total	123.04 (22.20)	70-159	108.62 (17.64)	71-143	97.73 (17.37)	52-127	
FFMQ Observing							
Male	23.62 (6.88)	13-40	23.72 (6.50)	10-35	24.22 (5.61)	14-35	
Female	23.47 (6.52)	8-33	28.00 (6.49)	16-37	25.25 (8.77)	9-36	1.24 (.29)
Total	23.57 (6.71)	8-40	25.24 (6.75)	10-37	24.63 (6.92)	9-36	
FFMQ Describing							
Male	26.84 (7.73)	9-40	26.28 (7.06)	12-40	24.56 (6.55)	14-39	
Female	22.06 (7.50)	9-36	29.63 (6.15)	16-37	27.42 (5.89)	19-37	4.39 **(.01)**
Total	25.33 (7.92)	9-40	27.47 (6.87)	12-40	25.70 (6.35)	14-39	
FFMQ Acting with Awareness							
Male	28.89 (7.07)	13-40	29.79 (5.75)	17-40	28.17 (6.62)	16-40	
Female	23.59 (6.21)	11-34	27.50 (4.10)	17-33	26.00 (9.46)	8-40	.71 (.49)
Total	27.22 (7.19)	11-40	28.98 (5.29)	17-40	27.30 (7.80)	8-40	
FFMQ Non-Judging							
Male	27.86 (6.94)	8-38	30.24 (7.03)	13-40	23.00 (6.02)	16-38	
Female	23.12 (8.22)	8-39	28.62 (6.86)	19-40	25.58 (9.01)	11-40	2.34 (.10)
Total	26.37 (7.62)	8-39	29.67 (6.94)	13-40	24.03 (7.33)	11-40	
FFMQ Non-Reactivity							
Male	21.05 (4.67)	10-35	22.28 (5.65)	9-32	21.56 (3.87)	13-27	
Female	19.41 (5.97)	8-28	22.94 (5.45)	15-34	19.42 (5.87)	11-29	.69 (.50)
Total	20.54 (5.11)	8-35	22.51 (5.53)	9-34	20.70 (4.79)	11-29	

Table 5.3. Meditation Indices (Means and SDs) for Meditator, Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT) groups, as well as the inferential statistics for the independent t-tests of group differences (MaSD vs OMT).

	All Meditators (N = 75)		**MaSD (N = 45)**		**OMT (N = 30)**		**Group Difference**
Meditation Experience Index	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	$t_{(73)}$ (*p*-value)
Total Years of Regular Practice	2.49 (3.00)	0*-15	2.76 (3.15)	0-15	2.08 (2.77)	0-12	.97 (.34)
Total Hours of Regular Practice	266.37 (431.04)	0*-2710	295.36 (502.02)	0-2710	222.89 (297.39)	0-936	.71 (.48)
Total Hours of Regular Practice with Retreats	361.17 (529.72)	0*-2905	365.92 (558.77)	0-2905	354.06 (492.16)	0-1910	.09 (.93)
Intensity of Regular Practice	-787.93 (884.67)	-4305-220	-865.66 (901.42)	-4305-(-46)	-668.11 (863.21)	-3444-220	-.85 (.40)

* 0 is the cut off point for moderate practice as defined by the Intensity of Practice (IoP) criterion and the formula used to calculate it, i.e. the IoP values equal to or below 0 indicate moderate practice (defined as at least 1 hour once a day over the years of practice), the IoP values above 0 indicate intensive practice

5.3.3 *Neutral Attentional Blink Performance*

5.3.3.1 *Response Accuracy (RA)*

5.3.3.1.1 *Comparison of Meditator and Non-meditator Groups*

There were significant main effects of Target Position [$F_{1, 125} = 103.8$, $p < .001$, $\eta_p^2 = .45$], with lower T2 than T1 RA, and Lag [$F_{2.3, 293.7} = 51.4$, $p <.001$, $\eta_p^2 = .29$], with higher RA at longer than shorter lags. Target Position x Lag interaction was also significant [$F_{2.1, 260.1} = 51.3$, $p < .001$, $\eta_p^2 = .29$], with all pairwise comparisons between lags being significant ($p < .001$) for T2 RA, with T2 RA being significantly lower at shorter than longer lags (Table 5.4 for means and SDs and Figure 5.3).

Contrary to H1, the main effect of Group and all interactions involving Group were not significant (Table 5.4).

5.3.3.1.2 *Comparison of MaSD, OMT, and Non-meditator Groups*

The main effects of Target Position [$F_{1, 123} = 103.2$, $p < .001$, $\eta_p^2 = .46$], Lag [$F_{2.4, 291.1} = 55.7$, $p < .001$, $\eta_p^2 = .31$] and Target Position x Lag [$F_{2.1, 259.2} = 57.7$, $p < .001$, $\eta_p^2 = .32$] interaction were significant. As expected, T2 RA was lower at shorter than longer lags (Table 5.4), with all pairwise comparisons between lags being significant ($p < .004$). The interactions of Target Position x GroupMT [$F_{2, 123} = .33$, $p = .72$, $\eta_p^2 = .005$] and Target Position x Lag x GroupMT [$F_{4.2, 259.2} = 2.03$, $p = .09$, $\eta_p^2 = .03$] were not significant.

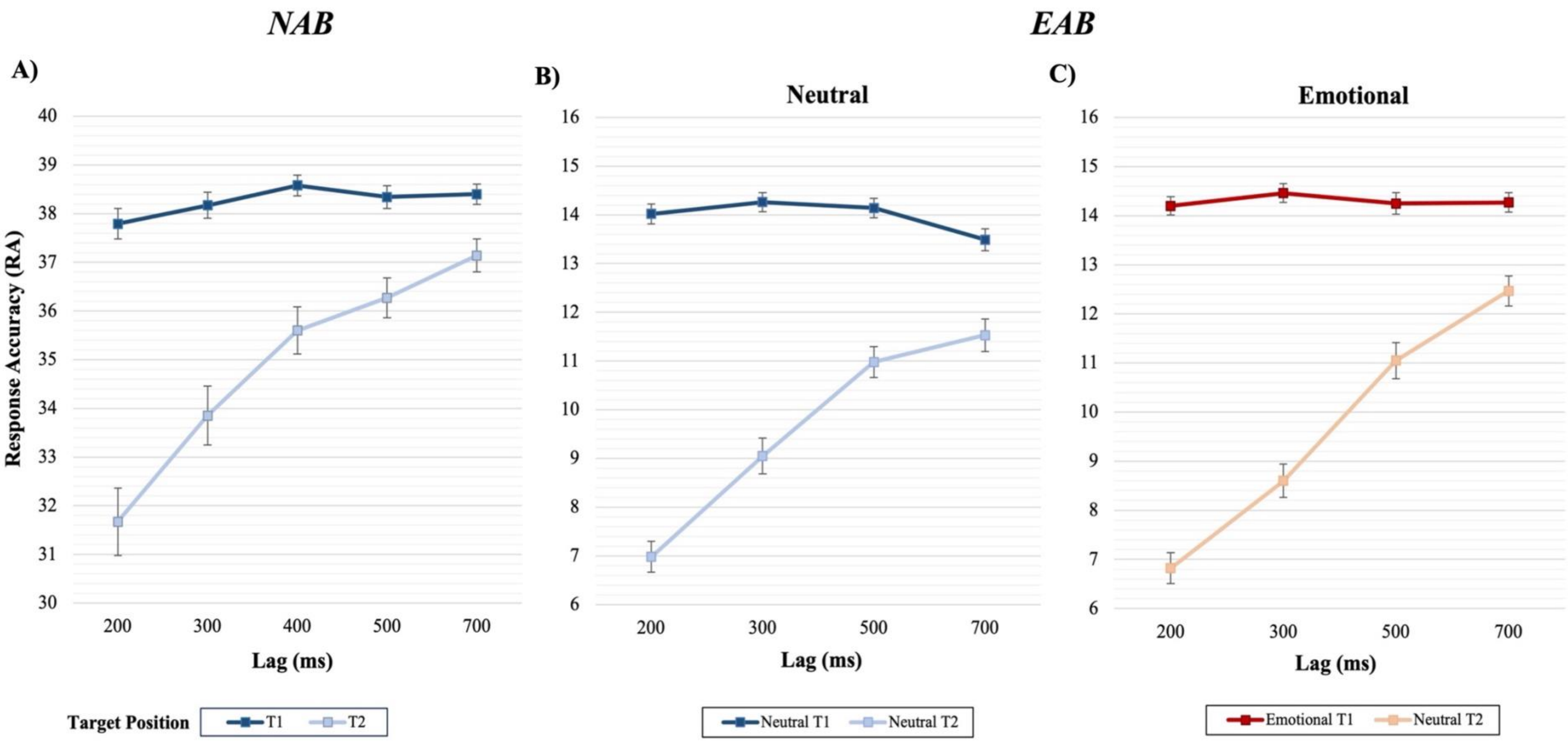
Table 5.4. Mean (SD) Response Accuracy for T1 and T2 target position during *Neutral Attentional Blink (NAB)* paradigm at lags 200 ms, 300 ms, 400 ms, 500 ms, and 700 ms for Non-meditator group and Meditator group/subgroups (GroupMT: MaSD vs OMT), as well as the inferential statistics for the results of 2 (Target Position: T1, T2) x 5 (Lag: 200 ms, 300 ms, 400 ms, 500 ms, 700 ms) x 2 (Group: Non-meditator, Meditator)/3 (Non-meditator, GroupMT: MaSD, OMT) x 2 (Sex: Male, Female) repeated-measures ANOVAs.

NAB	Lag (ms)	Target Position	Non-meditators (N = 54) Mean (SD)	Meditators (N = 75) Mean (SD)	MaSD (N = 45) Mean (SD)	OMT (N = 30) Mean (SD)
	200	T1	37.89 (2.06)	37.72 (4.35)	37.31 (5.43)	38.33 (1.75)
		T2	31.89 (6.78)	31.51 (8.65)	32.13 (9.30)	30.57 (7.63)
	300	T1	38.52 (1.97)	37.92 (3.61)	37.49 (4.46)	38.57 (1.55)
		T2	34.00 (6.62)	33.75 (7.09)	33.60 (8.14)	33.97 (5.26)
	400	T1	38.89 (1.65)	38.36 (2.87)	37.96 (3.55)	38.97 (1.07)
		T2	35.93 (4.60)	35.37 (6.05)	35.16 (7.27)	35.70 (3.63)
	500	T1	38.48 (1.83)	38.24 (3.07)	37.80 (3.76)	38.90 (1.37)
		T2	35.96 (4.12)	36.49 (4.97)	36.09 (5.99)	37.10 (2.85)
	700	T1	38.39 (1.79)	38.41 (2.75)	38.09 (3.35)	38.90 (1.35)
		T2	37.06 (3.21)	37.20 (4.24)	36.62 (5.18)	38.07 (2.00)

Non-meditator vs Meditator Groups	**Within-subject main effects:** **Target Position:** $F_{1, 125} = 103.8$, ***p* <.001**, $\eta_p^2 = .45$ **Lag:** $F_{2.3, 293.7} = 51.4$, ***p* <.001**, $\eta_p^2 = .29$ **Between-subject main effects:** **Group:** $F_{1, 125} = .10$, $p = .76$, $\eta_p^2 = .001$ **Sex:** $F_{1, 125} = .68$, $p = .41$, $\eta_p^2 = .005$	**Interactions:** **Target Position x Group:** $F_{1, 125} = .08$, $p = .78$, $\eta_p^2 = .001$ **Target Position x Group x Sex:** $F_{1, 125} = .00$, $p = .99$, $\eta_p^2 = .000$ **Lag x Group:** $F_{2.3, 293.7} = .63$, $p = .56$, $\eta_p^2 = .005$ **Lag x Group x Sex:** $F_{2.3, 293.7} = .17$, $p = .88$, $\eta_p^2 = .001$ **Target Position x Lag:** $F_{2.1, 260.1} = 51.3$, ***p* <.001**, $\eta_p^2 = .29$ **Target Position x Lag x Group:** $F_{2.1, 260.1} = .64$, $p = .53$, $\eta_p^2 = .005$ **Target Position x Lag x Group x Sex:** $F_{2.1, 260.1} = .22$, $p = .81$, $\eta_p^2 = .002$ **Group x Sex:** $F_{1, 125} = .003$, $p = .95$, $\eta_p^2 = .000$
Non-meditator vs MaSD vs OMT Groups	**Within-subject main effects:** **Target Position:** $F_{1, 123} = 103.2$, ***p* <.001**, $\eta_p^2 = .46$ **Lag:** $F_{2.4, 291.1} = 55.7$, ***p* <.001**, $\eta_p^2 = .31$ **Between-subject main effects:** **GroupMT:** $F_{2, 123} = .25$, $p = .78$, $\eta_p^2 = .004$ **Sex:** $F_{1, 123} = .60$, $p = .44$, $\eta_p^2 = .005$	**Interactions:** **Target Position x GroupMT:** $F_{2, 123} = .33$, $p = .72$, $\eta_p^2 = .005$ **Target Position x GroupMT x Sex:** $F_{2, 123} = .001$, $p = .99$, $\eta_p^2 = .000$ **Lag x GroupMT:** $F_{4.7, 291.1} = 1.06$, $p = .38$, $\eta_p^2 = .02$ **Lag x GroupMT x Sex:** $F_{4.7, 291.1} = .22$, $p = .95$, $\eta_p^2 = .004$ **Target Position x Lag:** $F_{2.1, 259.2} = 57.7$, ***p* <.001**, $\eta_p^2 = .32$ **Target Position x Lag x GroupMT:** $F_{4.2, 259.2} = 2.03$, ***p* = .09**, $\eta_p^2 = .03$ **Target Position x Lag x GroupMT x Sex:** $F_{4.2, 259.2} = .21$, $p = .94$, $\eta_p^2 = .003$ **GroupMT x Sex:** $F_{2, 123} = .03$, $p = .97$, $\eta_p^2 = .000$

Abbreviations: GroupMT, Group Meditation Tradition; MaSD, Mindfulness as Secularly Defined; OMT, Other Meditation Traditions

Figure 5.3. T1 and T2 Response Accuracy (RA) in the *Neutral Attentional Blink (NAB)* and *Emotional Attentional Blink (EAB)* Paradigms



A) T1 and T2 RA in the *NAB* paradigm. **B)** T1 and T2 RA for the neutral condition in the *EAB* paradigm. **C)** T1 and T2 RA for the emotional condition in the *EAB* paradigm. Error bars represent standard error of the mean.

5.3.3.2 *Reaction Time (RT)*

There were no significant main effects or interactions involving Group or Sex in Meditator or Non-meditator groups, as well as in MaSD, OMT and non-meditator groups, for *NAB* RT performance (Supplementary Materials: Appendix A, Table A1).

5.3.3.3 *Relationships of NAB magnitude with Trait Mindfulness and Equanimity*

Partially supporting H3, %*NAB* and FFMQ *Non-reactivity* scores were negatively associated in Meditator group at lag 500 ms [r = -.29, p = .01]. The difference in the strength of the correlation coefficients for the Meditator and Non-meditator groups was significant (z = -2.07, p = .02) using Fisher's z transformation (Fisher, 1921). Unexpectedly, in OMT group %*NAB* was *positively* associated with FFMQ *Non-judging* at lag 300 ms [r = .36, p = .05], as well as *Describing* [r = .37, p = .05], *Acting with Awareness* [r = .41, p = .03], *Non-judging* [r = .55, p = .002] and *total* scores [r = .40, p = .03] at lag 500 ms (See Supplementary Materials: Appendix A, Table A3 for all correlations).

No significant associations were observed between %*NAB* and NAS-7 scores either in the whole sample or any of the groups/subgroups (Supplementary Materials: Appendix A, Table A3).

5.3.4 *Emotional Attentional Blink Performance*

5.3.4.1 *Response Accuracy (RA)*

5.3.4.1.1 *Comparison of Meditator and Non-meditator Groups*

There were significant main effects of Target Position [$F_{1, 125}$ = 626.1, p < .001, η_p^2 = .83], Condition [$F_{1, 125}$ = 6.32, p = .01, η_p^2 = .05], and Lag [$F_{2.7, 337.7}$ = 116.0, p <.001, η_p^2 = .48], as well as significant Target Position x Lag [$F_{2.2, 280.9}$ = 278.3, p < .001, η_p^2 = .69] and Condition x Lag [$F_{3, 375}$ = 8.51, p < .001, η_p^2 = .06] interactions. There was also a trend for a significant Target Position x Condition x Lag interaction [$F_{2.8, 346.8}$ = 2.36, p = .08, η_p^2 = .02], which became significant when covarying for age (p = .05). Across the whole sample, all pairwise comparisons between lags were significant at p <.001 for T2 RA, indicating a significantly lower T2 RA at shorter than longer lags (Table 5.5 for means and SDs; Figure 5.3). T2 RA was significantly lower than T1 RA for both *neutral* and *emotional* conditions across all lags (p

<.001), showing an overall *AB* effect. The *EAB* effect was only present at lag 300 ms across the whole sample, with T2 RA for the *emotional* condition being significantly lower than for the *neutral* condition (p = .03). For lag 700 ms, which is a control interval outside of the AB interval range, both T1 RA and T2 RA for the *emotional* condition were significantly higher than T1 RA and T2 RA for the *neutral* condition (p < .001), respectively.

The main effect of Group was not significant (Table 5.5); however, there were significant Lag x Group x Sex [$F_{2.7, 337.7} = 2.70$, $p = .05$, $\eta_p^2 = .02$], Condition x Lag x Group x Sex [$F_{3, 375} = 3.45$, $p = .02$, $\eta_p^2 = .03$] (Figure 5.4), and a trend for Target Position x Condition x Lag x Group x Sex [$F_{2.8, 346.8} = 2.30$, $p = .08$, $\eta_p^2 = .02$] interactions. With age as a covariate, significance was either maintained or improved (Table 5.5).

Lower-order 2 (Target Position: T1, T2) x 2 (Condition: Neutral, Emotional) x 2 (Group: Meditator, Non-meditator) x 2 (Sex: Male, Female) ANCOVAs, covarying for age, were performed separately at each lag to further investigate Target Position x Condition x Lag x Group x Sex interaction. Planned pair-wise contrasts (using ANOVAs, independent or paired-samples t-tests, as appropriate) were used to follow-up significant (or trend) interactions of interests (i.e. lags 200ms and 300ms as per H2-testing) as reported below. The planned pair-wise comparisons were also performed for lags 500ms and 700ms to ensure that any significant meditation by sex effects were specific to *AB*-inducing intervals.

For lag 200 ms, there was a significant Condition x Group x Sex interaction [$F_{1, 124} = 3.94$, $p = .05$, $\eta_p^2 = .03$] and a trend for Target x Group x Sex [$F_{1, 124} = 2.88$, $p = .09$, $\eta_p^2 = .02$] interaction. Univariate ANCOVAs (controlling for age) with Group as a between-subject factor performed in males and females separately did not show any significant differences between meditators and non-meditators for T1 RA or T2 RA either for the *neutral* or *emotional* condition. Univariate ANCOVAs (controlling for age) with Sex as a between-subject factor performed in meditators and non-meditators separately showed that female meditators performed at trend-level better than male meditators when identifying T1 *emotional* stimuli [Male: T1 RA Mean = 13.79, SD = 2.24; Female: T2 RA Mean = 14.75, SD = 1.67; $F_{1, 72} = 3.51$, $p = .065$, $\eta_p^2 = .047$], with no significant T2 RA differences between the sexes either for the *neutral* or *emotional* conditions. There were no significant differences between male and female non-meditators for T1 or T2 RA either in *neutral* or *emotional* conditions. Paired-sample *t*-tests for T1/T2 RA in *neutral* vs *emotional* conditions performed separately in female and male meditators/non-meditators revealed that female meditators performed significantly better at both T1 [t_{27} = -2.31, p = .03] and T2 [t_{27} = -2.05, p = .05] target identification when T1 stimuli were *emotional* rather than *neutral* (*neutral* condition: T1 RA Mean = 14.11, SD = 2.15; T2 RA Mean = 6.32, SD = 3.04; *emotional* condition: T1 RA Mean = 14.75, SD = 1.67, T2 RA Mean = 7.07, SD = 3.37). There were no such performance differences in male meditators or male and female non-meditators (Figure 5.4-A).

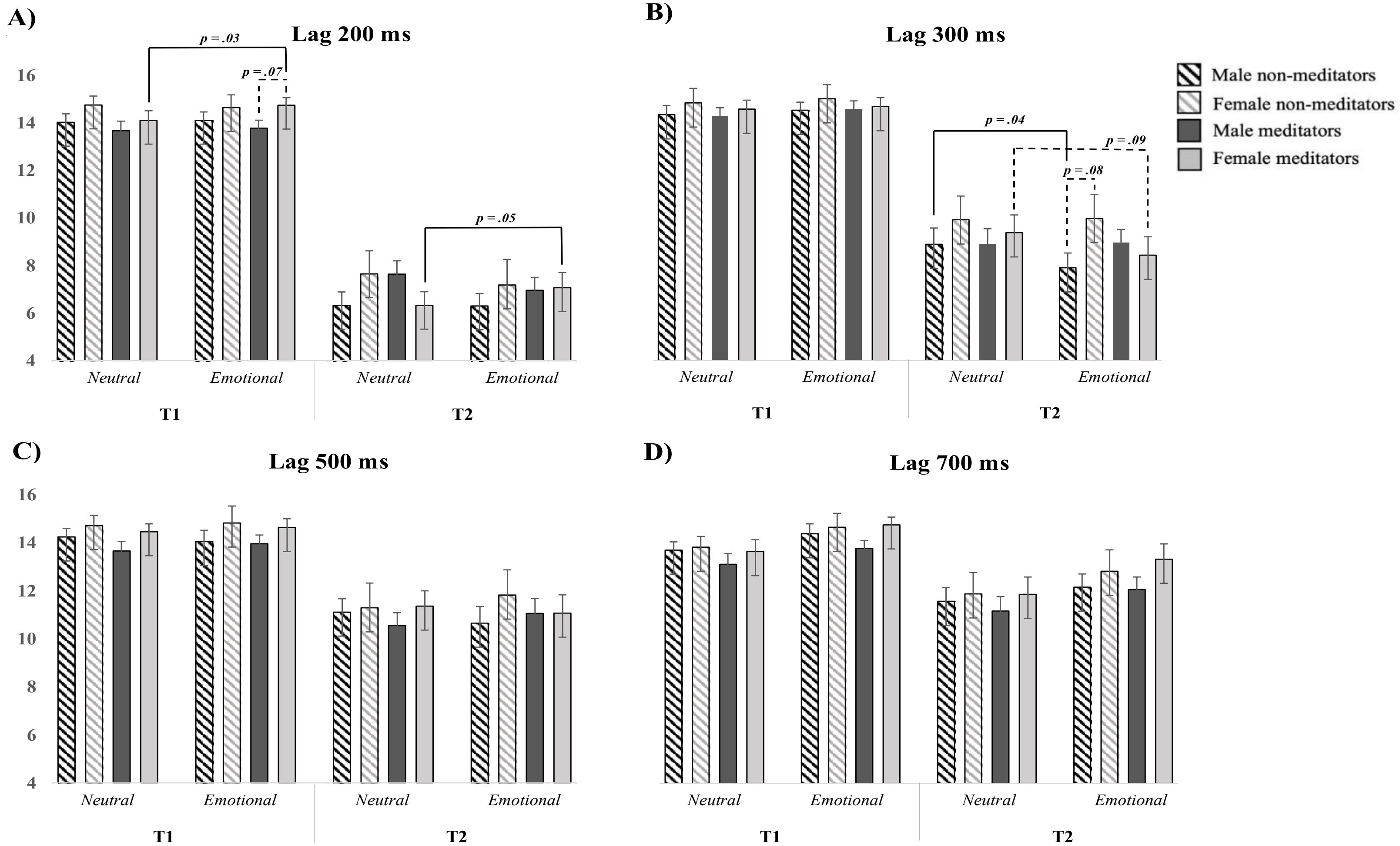
For lag 300 ms, there was a significant Target x Condition x Group x Sex interaction [$F_{1, 124}$ = 4.2, p = .043, η_p^2 = .03]. Univariate ANCOVAs (controlling for age) with Group as a between-subject factor performed in males and females separately did not show any significant differences between meditators and non-meditators for T1 RA or T2 RA either for the *neutral* or *emotional* condition. Univariate ANCOVAs (controlling for age) with Sex as a between-subject factor performed in meditators and non-meditators separately showed that female non-meditators performed at trend-level better than male non-meditators when identifying T2 target stimuli when T1 stimuli were *emotional* [Male: T2 RA Mean = 7.84, SD = 3.72; Female: T2 RA Mean = 9.88, SD = 4.06; $F_{1, 51}$ = 3.26, p = .077, η_p^2 = .06]; there were no significant T1 RA differences between the sexes either for the *neutral* or *emotional* conditions. Paired-sample *t*-tests for T1/T2 RA in *neutral* vs *emotional* conditions performed separately in female and male meditators/non-meditators revealed *EAB*-related effect in male non-meditators and female meditators, with male non-meditators being significantly better at identifying T2 targets when T1 target stimuli were *neutral* rather than *emotional* [*neutral* condition: T2 RA Mean = 8.81, SD = 4.10; *emotional* condition: T2 RA Mean = 7.84, SD = 3.72; t_{36} = 2.11, p = .04], and female meditators showing a trend for significantly higher mean T2 RA in *neutral* than *emotional* condition [*neutral* condition: T2 RA Mean = 9.29, SD = 3.88; *emotional* condition: T2 RA Mean = 8.36, SD = 4.00; t_{27} = 1.75, p = .09]. There were no significant T2 RA differences between *neutral* and *emotional* conditions in female non-meditators or male meditators (Figure 5.4-B).

There were no significant Target x Condition x Group x Sex interactions for lags 500 ms (p = .11) or 700 ms (p = .94) (Figure 5.4 - C and D), confirming that the interactive effect of meditation by sex is specific to *AB*-inducing lags 200ms and 300ms.

5.3.4.1.2 *Comparison of MaSD, OMT, and Non-meditator Groups*

There were no significant interactions involving GroupMT or GroupMT by Sex (Table 5.5).

Figure 5.4. Response Accuracy (RA) of Male and Female Meditators and Non-Meditators in the *Emotional Attentional Blink (EAB)* Paradigm by Lag



The *p* values are shown only for the significant (and trend toward significant) planned pairwise comparisons investigating Target Position by Condition by Lag by Group by Sex interaction.

Table 5.5. Mean (SD) Response Accuracy for T1 and T2 target position during *Emotional Attentional Blink (EAB)* paradigm at lags 200 ms, 300 ms, 500 ms, and 700 ms for Non-meditator group and Meditator group/subgroups (GroupMT: MaSD vs OMT), as well as the inferential statistics for the results of 2 (Target Position: T1, T2) x 2 (Condition: Neutral, Emotional) x 4 (Lag: 200 ms, 300 ms, 500 ms, 700 ms) x 2 (Group: Non-meditator, Meditator)/3 (Non-meditator, GroupMT: MaSD, OMT) x 2 (Sex: Male, Female) repeated-measures ANOVAs.

EAB	**Lag (ms)**	**Target Position**	**Non-meditators (N = 54) Mean (SD)**	**Meditators (N = 75) Mean (SD)**	**MaSD (N = 45) Mean (SD)**	**OMT (N = 30) Mean (SD)**
T1 Neutral /T2 Neutral	200	T1	14.26 (2.02)	13.84 (2.53)	13.87 (2.51)	13.80 (2.59)
		T2	6.74 (3.65)	7.15 (3.61)	6.89 (3.71)	7.53 (3.48)
	300	T1	14.31 (2.34)	14.21 (2.21)	14.22 (2.25)	14.20 (2.19)
		T2	9.13 (4.07)	8.99 (4.20)	8.84 (4.13)	9.20 (4.36)
	500	T1	14.39 (2.08)	13.96 (2.37)	13.84 (2.53)	14.13 (2.13)
		T2	11.17 (3.67)	10.85 (3.59)	10.67 (3.77)	11.13 (3.36)
	700	T1	13.74 (2.00)	13.31 (2.87)	13.27 (2.84)	13.37 (2.97)
		T2	11.67 (3.52)	11.43 (3.97)	11.49 (3.99)	11.33 (4.00)
T1 Emotional /T2 Neutral	200	T1	14.28 (2.18)	14.15 (2.08)	14.29 (1.88)	13.93 (2.38)
		T2	6.57 (3.61)	7.00 (3.54)	7.16 (3.66)	6.77 (3.40)
	300	T1	14.50 (2.10)	14.43 (2.23)	14.51 (2.29)	14.30 (2.15)
		T2	8.48 (3.91)	8.68 (3.85)	8.44 (3.79)	9.03 (3.96)
	500	T1	14.30 (2.85)	14.21 (2.27)	14.40 (2.32)	13.93 (2.21)
		T2	11.02 (4.27)	11.07 (4.11)	11.07 (4.11)	11.07 (4.19)
	700	T1	14.46 (2.42)	14.13 (2.13)	14.22 (2.16)	14.00 (2.10)
		T2	12.37 (3.42)	12.53 (3.53)	12.51 (3.50)	12.57 (3.63)

Non-meditator vs Meditator Groups

Within-subject main effects:

Target Position: $F_{1, 125} = 626.1$, ***p* <.001**, $\eta_p^2 = .83$

Condition: $F_{1, 125} = 6.32$, ***p* = .01**, $\eta_p^2 = .05$

Lag: $F_{2.7, 337.7} = 116.0$, ***p* <.001**, $\eta_p^2 = .48$

Between-subject main effects:

Group: $F_{1, 125} = .13$, $p = .72$, $\eta_p^2 = .001$

Sex: $F_{1, 125} = 1.31$, $p = .26$, $\eta_p^2 = .010$

Interactions:

Target Position x Group: $F_{1, 125} = .25$, $p = .62$, $\eta_p^2 = .002$
Target Position x Group x Sex: $F_{1, 125} = 1.52$, $p = .22$, $\eta_p^2 = .01$

Condition x Group: $F_{1, 125} = 1.29$, $p = .26$, $\eta_p^2 = .01$
Condition x Group x Sex: $F_{1, 125} = .20$, $p = .66$, $\eta_p^2 = .002$

Lag x Group: $F_{2.7, 337.7} = .11$, $p = .95$, $\eta_p^2 = .001$
Lag x Group x Sex: $F_{2.7, 337.7} = 2.70$, ***p* = .05**, $\eta_p^2 = .02$ (~ $p = .06$)

Target Position x Condition: $F_{1, 125} = 3.62$, $p = .06$, $\eta_p^2 = .03$
Target Position x Condition x Group: $F_{1, 125} = .00$, $p = .99$, $\eta_p^2 = .00$
Target Position x Condition x Group x Sex: $F_{1, 125} = 1.71$, $p = .19$, $\eta_p^2 = .01$

Target Position x Lag: $F_{2.2, 280.9} = 278.3$, ***p* <.001**, $\eta_p^2 = .69$
Target Position x Lag x Group: $F_{2.2, 280.9} = .73$, $p = .50$, $\eta_p^2 = .006$

		Target Position x Lag x Group x Sex: $F_{2.2, 280.9}$ = 1.79, *p* = .16, η_p^2 = .01 **Condition x Lag:** $F_{3, 375}$ = 8.51, ***p* <.001**, η_p^2 = .06 **Condition x Lag x Group:** $F_{3, 375}$ = .20, *p* = .90, η_p^2 = .002 **Condition x Lag x Group x Sex:** $F_{3, 375}$ = 3.45, ***p* = .02**, η_p^2 = .03 (~ *p* = .02*)* **Target Position x Condition x Lag:** $F_{2.8, 346.8}$ = 2.36, *p* =.08, η_p^2 = .02 **Target Position x Condition x Lag x Group:** $F_{2.8, 346.8}$ = .21, *p* = .87, η_p^2 = .002 **Target Position x Condition x Lag x Group x Sex:** $F_{2.8, 346.8}$ = 2.30, *p* = .08, η_p^2 = .02 (~ *p* = .07) **Group x Sex:** $F_{1, 125}$ = .11, *p* = .74, η_p^2 = .001
Non-meditator vs MaSD vs OMT Groups	**<u>Within-subject main effects:</u>** **Target Position:** $F_{1, 123}$ = 611.2, ***p* <.001**, η_p^2 = .83 **Condition:** $F_{1, 123}$ = 7.07, ***p* = .009**, η_p^2 = .05 **Lag:** $F_{2.7, 332.2}$ = 112.6, ***p* <.001**, η_p^2 = .48 **<u>Between-subject main effects:</u>** **GroupMT:** $F_{2, 123}$ = .09, *p* = .92, η_p^2 = .001 **Sex:** $F_{1, 123}$ = 1.27, *p* = .26, η_p^2 = .010	**<u>Interactions:</u>** **Target Position x GroupMT:** $F_{2, 123}$ = .62, *p* = .54, η_p^2 = .01 **Target Position x GroupMT x Sex:** $F_{2, 123}$ = 1.49, *p* = .23, η_p^2 = .02 **Condition x GroupMT:** $F_{2, 123}$ = 1.86, *p* = .16, η_p^2 = .03 **Condition x GroupMT x Sex:** $F_{2, 123}$ = .16, *p* = .85, η_p^2 = .003 **Lag x GroupMT:** $F_{5.4, 332.2}$ = .18, *p* = .98, η_p^2 = .003 **Lag x GroupMT x Sex:** $F_{5.4, 332.2}$ = 1.47, *p* = .19, η_p^2 = .02 **Target Position x Condition:** $F_{1, 123}$ = 3.30, *p* = .07, η_p^2 = .03 **Target Position x Condition x GroupMT:** $F_{2, 123}$ = .16, *p* = .85, η_p^2 = .003 **Target Position x Condition x GroupMT x Sex:** $F_{2, 123}$ = .91, *p* = .41, η_p^2 = .02 **Target Position x Lag:** $F_{2.2, 275.4}$ = 271.5, ***p* <.001**, η_p^2 = .69 **Target Position x Lag x GroupMT:** $F_{4.5, 275.4}$ = .64, *p* = .65, η_p^2 = .01 **Target Position x Lag x GroupMT x Sex:** $F_{4.5, 275.4}$ = 1.06, *p* = .38, η_p^2 = .02 **Condition x Lag:** $F_{3, 369}$ = 9.10, ***p* <.001**, η_p^2 = .07 (~ *p* = .08) **Condition x Lag x GroupMT:** $F_{6, 369}$ = .56, *p* = .77, η_p^2 = .009 **Condition x Lag x GroupMT x Sex:** $F_{6, 369}$ = 1.86, *p* = .09, η_p^2 = .03 **Target Position x Condition x Lag:** $F_{2.8, 342.6}$ = 2.67, ***p* = .05**, η_p^2 = .02 (~ *p* = .04) **Target Position x Condition x Lag x GroupMT:** $F_{5.6, 342.6}$ = .78, *p* = .58, η_p^2 = .01 **Target Position x Condition x Lag x GroupMT x Sex:** $F_{5.6, 342.6}$ = 1.25, *p* = .29, η_p^2 = .02 **GroupMT x Sex:** $F_{2, 123}$ = .28, *p* = .76, η_p^2 = .005

~ *p* value when covarying for age

Abbreviations: GroupMT, Group Meditation Tradition; MaSD, Mindfulness as Secularly Defined; OMT, Other Meditation Traditions

5.3.4.2 *Reaction Time (RT)*

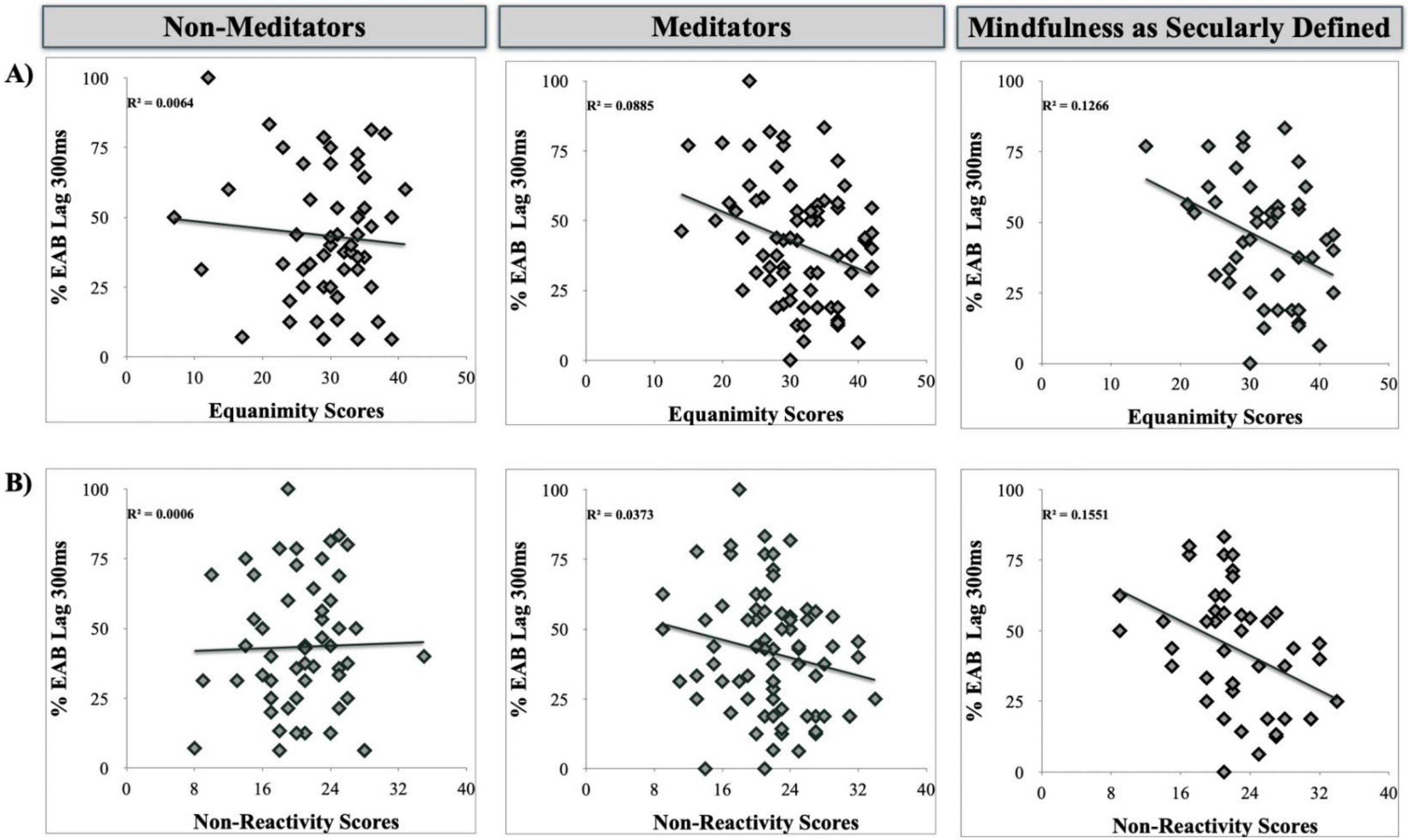
There were no significant main effects or interactions involving Group or Sex in Meditator or Non-meditator groups, as well as in MaSD, OMT and non-meditator groups, for *EAB* RT performance (Supplementary Materials, Appendix A, Table A2).

5.3.4.3 *Relationships of EAB magnitude with Trait Mindfulness and Equanimity*

Confirming H3, higher NAS-7 scores in Meditator group were significantly correlated with lower *%EAB* at lag 300 ms in the *emotional* condition [r = -.27*,* p =.02], as well as lags 500 ms [r = -.25*,* p =.03] and 700 ms [r = -.28*,* p =.02] in the *neutral* condition. Negative correlation between NAS-7 scores and *%EAB* at lag 300 ms in the *emotional* condition was also significant in MaSD group [r = -.33*,* p =.03] (Figure 5.5). Using Fisher's z transformation (Fisher, 1921), the difference in the strength of the correlation coefficients for the Meditator and Non-meditator groups was significant for the association between NAS-7 scores and *%EAB* for the *neutral* condition at lag 700ms (z' = -.1.74, p = .04) and for the MaSD and Non-meditator groups for the association between NAS-7 scores and *%EAB* for the *emotional* condition at lag 300ms (z' = -1.69, p = .04). The difference was not significant for the Meditator and Non-meditator groups for the association between NAS-7 scores and *%EAB* for the *emotional* condition at lag 300ms (z' = -1.57, p = .06), the association between NAS-7 and *%EAB* for the *neutral* condition at lag 500ms (z' = -1.23, p = .11), or for the MaSD and OMT groups for the association between NAS-7 and *%EAB* for the *emotional* condition at lag 300ms (z' = -.31, p = .38).

In further support of H3, MaSD group showed negative associations of FFMQ *Non-reactivity* scores with *%EAB* at lag 300 ms in the *emotional* condition [r = -.42*,* p =.004; Figure 5.5] and lag 700 ms in the *neutral* condition [r = -.32, p =.03], as well as with *Acting with Awareness* at lag 300 ms [r = -.35*,* p =.02] and lag 500 ms [r = -.35*,* p =.02] in the *neutral* condition. In Meditator group, FFMQ *Non-reactivity* scores were negatively associated with *%EAB* at lag 700 ms [r = -.23*,* p = .04] in the *neutral* condition (Supplementary Materials, Appendix A, Table A3). Using Fisher's z transformation (Fisher, 1921), the difference in the strength of the correlation coefficients for the MaSD and Non-meditator groups was significant for the association between FFMQ *Non-reactivity* scores and *%EAB* for the *emotional* condition at lag 300ms (z' = -2.34, p = .01), with this significance becoming stronger for the MaSD and OMT groups (z' = -2.59, p = .005). The difference was also significant for the Meditator and Non-meditator groups for the association between FFMQ *Non-reactivity* scores and *%EAB* for the *neutral* condition at lag 700ms (*z'* = -1.77, *p* = .04), for the MaSD and Non-meditator groups for the association between FFMQ *Non-reactivity* scores and *%EAB* for the *neutral* condition at lag 700ms (*z'* = -2.02, *p* = .02) but not significant for MaSD and OMT groups (*z'* = -1.1, *p* = .14).

Figure 5.5. Relationship between *Emotional Attentional Blink (EAB)* Performance, Trait *Equanimity* and *Non-Reactivity* in Non-Meditators, Meditators and Mindfulness as Secularly Defined (MaSD)



A) Associations between *%EAB* at lag 300 ms with *equanimity* scores for non-meditators, meditators, and MaSD.
B) Associations between *%EAB* at lag 300 ms with *non-reactivity* scores for non-meditators, meditators, and MaSD.

5.3.5 *Relationships between NAB and EAB Paradigm Performance*

The relationships between %*NAB* and *%EAB* were explored across the common lags of the *NAB* and *EAB* paradigms (200 ms, 300 ms, 500 ms and 700 ms) in the whole sample, Meditator and Non-meditator groups, as well as MaSD and OMT subgroups. There were a number of significant correlations at each lag for the whole sample and Non-meditator group; for the Meditator group, except at lag 200 ms where the *%NAB* significantly correlated with *%EAB* only during the *emotional* condition; for the MaSD group except at lag 200 ms, with most *p* values being below the adjusted significance level of .001 for the lags 300 - 700 ms. (Supplementary Materials, Appendix A, Table A4).

5.4 Discussion

The study investigated the effects of meditation on *NAB* and *EAB*, as well as the associations of *NAB*/*EAB* paradigm performance with trait *mindfulness* and *equanimity*. Contrary to H1 and H2, there were no effects of meditation, overall or mindfulness as secularly defined versus other approaches, on either *NAB* or *EAB* paradigm performance. As predicted (H3), in meditators smaller *EAB* (higher T2 RA following *emotional* T1 stimuli) was associated with higher trait *non-reactivity* (at trend level) and *equanimity* at 300ms interval, with these relationships being specific (significant) to mindfulness meditators. This is the first study to observe an association between smaller *EAB* and higher trait *equanimity.* In female meditators response accuracy to both T1 and T2 *emotional* stimuli was enhanced at lag 200ms during the *EAB* paradigm performance, suggesting attenuated *attentional capture* by emotional stimuli at this interval; however, a reverse performance pattern was observed for lag 300ms. No such differences were observed in male meditators or non-meditators of either sex for the 200 ms interval.

5.4.1 *NAB and EAB Performance*

Both paradigms worked as intended, with *NAB/EAB* effects (lower T2 RA) being stronger at shorter than longer lags and the negative affective T1 stimuli producing stronger *EAB* than neutral ones across the whole sample during the *EAB* paradigm performance. Meditators, as a group, did not perform better on either *NAB* or *EAB* paradigms compared with non-meditators, with no differential effect for mindfulness meditation (MaSD group) compared with other meditation approaches (OMT group). The negative findings are most likely driven by the heterogeneity of the meditators sample due to opportunistic sampling in terms of types of meditation tradition/practice style, practice regularity, and expertise. Unequal numbers of meditators practicing different meditation approaches/styles did not allow using Dahl et al (2015) typology to split the meditators into subgroups by meditation practice families (*attentional, constructive, deconstructive*). Although the study was driven by the theoretical considerations of similarities between mindfulness meditation practice as formulated secularly and as taught within Tibetan Buddhism (Dzogchen/Mahamudra) and Zen Buddhism (Antonova et al., 2021; Dunne, 2011) by grouping them together (MaSD group), the OMT group was rather heterogeneous, including practices from both *constructive* (e.g., Metta or loving-kindness) and *deconstructive* (e.g., analytical meditation) families that might produce differential effects on *AB*, as reviewed previously. A recent study of FA and OM-practicing meditators did not observe smaller *AB* in meditators compared with non-meditators (Bailey et al., 2023). In the current study sample, most meditators from both groups (MaSD, OMT) practiced a combination of FA and OM (*attentional* family), which might have further contributed to the negative findings, since the evidence to date, reviewed in the introduction, tentatively suggests that the effects might be more robust for OM than FA practice styles.

5.4.2 *Relationships of AB Performance with Trait Equanimity and Non-reactivity*

Nevertheless, small-to-medium sized associations of trait *equanimity* and *non-reactivity* with *AB* performance were observed in meditators as a group, including for the intervals best capturing the *AB*. These associations were specific to mindfulness meditators (i.e. not significant in the meditators practicing other approaches). Higher trait *equanimity* in meditators was associated with significantly smaller *EAB* at 300 ms, 500 ms, and 700 ms intervals, with this association being specific to the *AB*-inducing interval of 300 ms in mindfulness meditators and the correlation coefficient being significantly stronger than in non-meditators (using Fisher's *z* transformations). OMT meditators showed this association only for 700 ms interval, which is outside of the *AB*-inducing time-period. Similarly, higher trait *non-reactivity* in meditators was associated with both smaller *NAB* and *EAB* at 500 ms and 700 ms, but only mindfulness meditators showed a significant relationship between higher *non-reactivity* and smaller *EAB* at the *AB*-inducing interval of 300 ms (in addition to 700 ms), with these correlations being significantly stronger than in non-meditators. Previous research reported higher dispositional *non-reactivity* to be associated with smaller *EAB* (Makowski et al., 2019); however, in this study the relationships of higher trait *non-reactivity* and *equanimity* with smaller *EAB* were specific to trained but not dispositional trait *mindfulness*, since the same relationships were not observed in non-meditators. The differential effect of trained, rather than dispositional, trait *non-reactivit*y on *AB* performance in this study is in line with previous research that reported improved *non-reactivity* to be associated with attenuated *NAB* following an 8-week MT (Wang et al., 2021). Current findings further suggest that the effect of meditation practice on *AB* related to *non-reactivity* and *equanimity* might be better captured by using semantically meaningful target stimuli (*EAB* paradigm) rather than digits (*NAB* paradigm).

The associations of both higher trait *non-reactivity* and *equanimity* with smaller *EAB* (*emotional* condition)*,* but not *NAB,* in mindfulness meditators at 300 ms interval which captures *AB* effect most effectively (Wang et al., 2021; Willems et al., 2016), suggest that mindfulness meditation has an effect on *EAB* via reduced *attentional capture* by emotionally salient stimuli (Makowski et al., 2019). Furthermore, the significant correlations between *NAB* and *EAB* magnitudes across the lags in the whole sample, meditators and non-meditators in this study suggest that whereas *AB* performance generally might be reliant on more efficient attention allocation and/or information processing, *EAB* performance might be dependent on *attentional capture* mechanisms related to emotion regulation. Although there is a substantial overlap between the constructs of *non-reactivity* and *equanimity, equanimity* includes affective dimensions of empathy and warmth as well as the attitudes of tenderness and acceptance towards one's experiences (Sahdra et al., 2010). Trait *equanimity* was significantly but moderately correlated with *non-reactivity* (r =.502) in MaSD group. Taken together, previous and current findings suggest that *non-reactivity* and *equanimity* might constitute the mechanisms underpinning better *AB* performance in meditators more generally and mindfulness meditators specifically, with a distinct contribution of *equanimity* in addition to *non-reactivity* to better *EAB* performance. The differences in the levels of trait *equanimity* and *non-reactivity* across the samples might also explain inconsistent findings across the studies in relation to the effects of meditation on *NAB* and *EAB*, as reviewed in Chapter 3 (Section 3.2). Future studies should measure and report the levels of trait *equanimity* and *non-reactivity,* whether dispositional or trained, and investigate their associations with the *NAB/EAB* paradigm performance.

5.4.3 *EAB Performance: The Interactive Effect of Meditation and Sex*

The meditation effects on *EAB* were found to interact with sex. Female meditators had higher accuracy in identifying both T1 and T2 stimuli when T1 was *emotional* as compared with *neutral* at 200 ms interval of the *EAB* paradigm; that is, despite better identification of *emotional* T1 stimuli compared with *neutral* T1 stimuli, T2 stimuli identification was not compromised (i.e. did not increase *EAB*). RA for *emotional* T1 in female meditators was also marginally better than in male meditators. Male meditators did not differ in their accuracy of identifying T2 stimuli when T1 stimuli was *emotional* vs *neutral* at 200 ms interval. However, a different performance pattern for group by sex was observed at 300 ms interval. Both male and female meditators showed stronger *EAB* – that is, T2 RA was lower when T1 stimuli were *emotional* rather than *neutral* (significant in male meditators and at trend level in female meditators). Although there was no difference between males and females in response accuracy for *neutral* vs *emotional* T1 stimuli in the meditator group, female meditators performed at trend-level better than male meditators when identifying T2 stimuli when T1 stimuli were *emotional* rather than neutral, suggesting facilitation of performance by emotion and/or less *attentional capture* by emotional stimuli at this interval.

To further explore the mechanisms underlying the performance pattern in female meditators, correlations between their *EAB* performance and trait *equanimity* at 200 ms and 300 ms intervals were performed. There was no significant association for the 200 ms interval in female meditators but it was significant for the 300 ms interval (r = -.43, p = .02). This association between higher trait *equanimity* and smaller *EAB* at 300 ms interval was specific to female meditators, as there was no significant association between trait *equanimity*, either at 200 ms or 300 ms intervals, in male meditators or male and female non-meditators. Together, these findings indicate better attention allocation to affectively salient information in female meditators without this producing a stronger *EAB* effect, and even facilitating T2 stimuli identification, at the interval (200 ms) that might be critical in capturing the effects of meditation on *EAB*, with trait *equanimity* being a possible mechanism diminishing *attentional capture* by emotional T1 stimuli as indicated by its association with smaller *EAB* magnitude at 300 ms interval. The absence of an association between trait *equanimity* and *EAB* magnitude in female non-meditators in the presence of better identification of T2 stimuli when T1 stimuli were *emotional* rather than *neutral* suggests performance facilitation by emotion. Future research should disentangle the mechanisms underlying *EAB* paradigm performance in female meditators and non-meditators.

The sex-related meditation effects on *EAB* have to be treated with caution since they are reported here with uncorrected p values for planned comparisons to avoid committing Type II error (Rothman, 1990; Tabachnick & Fidell, 2007). Previous research has reported sex-specific effects of meditation on *AB* performance (Wang et al., 2023) with females showing reduced *NAB* following a 4-day meditation training and gaining greater benefits from mindfulness meditation training than males for affective processing (Kang et al., 2018; Kato et al., 2022; Rojiani et al., 2017; Smarinsky et al., 2023), as well as showing reduced affective reactivity (Correia et al., 2023) - a construct similar to *equanimity.* Hence, the above findings are likely to be true, rather than chance, but will need to be replicated in future studies.

5.4.4 *Limitations, Strengths, and Future Directions*

The study has some methodological limitations. The lack of meditation effects on *NAB* in the present study could be attributed to the heterogeneity of the meditators. Since opportunistic sampling resulted in heterogeneous group of meditators, the negative findings in relation to the effect of meditation on *NAB* performance should therefore be treated with caution. However, meaningful associations of higher trait *non-reactivity* and *equanimity* with weaker *NAB* and *EAB* were specific to meditators generally and mindfulness meditators in particular, and could explain inconsistent findings reported in previous *NAB* and *EAB* literature in relation to meditation. Future research would benefit from adopting a more targeted recruitment strategy when investigating the differential effects of meditation families, approaches or styles on *NAB* and *EAB*, assessing *NAB* and *EAB* magnitudes in relation to the levels of trait *equanimity* and *non-reactivity*.

Future studies should also consider including only 200 ms and/or 300 ms as *AB*-inducing intervals and 700ms as control interval to increase statistical power and to decrease the number of planned pair-wise contrasts to ensure a more robust investigation of meditation effects on *NAB* and *EAB*. This would also shorten the overall duration of the *AB* paradigms, which might be beneficial in detecting meditation-related effects, as the paradigms are very attention-demanding and those used in this study could have introduced some task fatigue.

To further enhance the ability to capture meditation-specific effects on *EAB*, future studies should improve the current *EAB* paradigm by selecting T1 target words that are highly arousing to maximise the *EAB* effect in non-meditators, since *highly,* but not *moderately,* arousing unpleasant T1 emotional stimuli increase *EAB* (Mathewson et al., 2008; Stein et al., 2009). In this study, negatively affective words used for the emotional T1 target stimuli in the *EAB* paradigm ranged in salience (arousal and valence), which might have diluted the *EAB* effect in non-meditators, affecting the ability to detect general (rather than sex-related) meditation effects on *EAB*. Furthermore, despite English language fluency in the participants from both UK and India, cultural differences might have affected *EAB* performance due to the potential differences in the degree of arousal and/or valence, as well as understanding and/or cultural relevance, of the neutral as well as emotional T1 target words.

The study has some strengths. This is the first study to examine and report an attenuating effect of both higher trait *non-reactivity* (as measured by FFMQ) and *equanimity* (as measured by NAS-7) on *EAB* in mindfulness meditators. Wang et al (2021) found the FFMQ scores and the scores on a 'peace of mind' measure (similar to NAS-7) to increase after an 8-week MT; however, only higher *non-reactivity* was found to be associated with better T2 accuracy following MT. Additionally, this study tested both *NAB* and *EAB* performance in the same sample of meditators and non-meditators, confirming positive associations between the two. This was also the first study to utilise emotional T1 words with negative valence instead of emotional faces. The red colour further added to the emotional saliency of the T1 stimuli. The between-groups design of the study allowed for better control of demand characteristics. The use of electrooculography (EOG) or other eye-blink tracking techniques should be used in future research to ensure that the observed *AB* effect is due to a cognitive inattentional blindness, rather than a spontaneous physical eye blink, on any given trial.

Future studies should replicate reported associations of trait *equanimity* and *non-reactivity* levels with *EAB* magnitudes in cross-sectional as well as longitudinal studies, with the view of establishing *EAB* paradigm performance as an objective measure of trait *equanimity* and *non-reactivity* in meditators as well as an outcome measure of MBIs.

5.4.5 *Conclusion*

To conclude, higher trait *non-reactivity* and *equanimity* were associated with smaller *EAB* in mindfulness meditators, highlighting their potential role as mechanisms of enhancing effects of mindfulness meditation practice on emotional information processing via reduced *attentional capture* by affective stimuli. Furthermore, female meditators demonstrated more efficient processing of emotional stimuli as indexed by their better identification of both T1 and T2 stimuli when the T1 stimuli were *emotional* rather than *neutral* at the *AB*-inducing interval of 200 ms, suggesting better attention allocation to and less *attentional capture* by affective information with trait *equanimity* being a possible mechanism.

Chapter 6 (Study 2): The Relationship between *Attentional Blink* and Sensory Gating in Meditators and Non-Meditators

Chapter Overview

As reviewed in Chapter 3 (Section 3.2), a number of *Attentional Blink (AB)* studies have demonstrated smaller *AB* in meditators (e.g. Fabio et al., 2018; van Leeuwen et al., 2009; Van Vugt & Slagter, 2014) due to a more efficient attentional capacity. Although there was no effect of meditation generally or mindfulness meditation in particular on either *NAB* or *EAB* performance in Study 1 (Chapter 5), higher trait *equanimity* and *non-reactivity* were found to be associated with smaller *AB* in mindfulness meditators specifically, suggesting that these qualities of mindful awareness are the underlying mechanisms of the effect of mindfulness meditation on *AB*.

As also reviewed in Chapter 3 (Section 3.3), meditators in general were not found to differ from non-meditators in their sensory gating as measured by *Prepulse Inhibition* (*PPI*). The effect of meditation on *PPI* could theoretically go in either direction, i.e. attenuation or enhancement (Chapter 3, Section 3.3). Attenuation would occur due to a more 'open' sensory information processing style and more efficient resource allocation for information processing (van Leeuwen et al., 2012) in meditators, as well as reduced *attentional capture* by the *prepulse*, resulting in a 'fresher' (less filtered) awareness of the *pulse*, as theorised in this thesis. Enhancement may occur due to more efficient sensory gating at shorter intervals (note that the common *prepulse*-to-*pulse* intervals used in a *PPI* paradigm are under 200 ms in duration, which is the shortest interval used in the *NAB* and *EAB* paradigms in Study 1 (Chapter 5). The evidence thus far suggests that at least in the meditators who self-report to be able to enter and sustain non-dual awareness (Kumari et al., 2024), the *PPI* is enhanced.

Despite the similarities in the *AB* and *PPI* paradigms in relation to two stimuli being presented in short succession and resulting either in *AB* or *PPI* effect, respectively, the relationships between performance on these paradigms has not been previously studied in meditators. Investigating the link between the *AB* and *PPI* in meditators vs non-meditators is, therefore, the main aim of Study 2. *AB* performance in Study 2 was assessed using the same *NAB* and

EAB paradigms as described and used in Study 1 (Chapter 5, Section 2.2), with the difference being that in Study 2 all paradigms (*NAB*, *EAB* and *PPI*) were administered in a lab.

The current chapter will first present a brief summary of the overview of sensory information processing (as measured by *PPI*) (for more details see Chapter 2, section 2.3), followed by an overview of attentional processing (as measured by the *AB)*, before providing theoretical assumptions of possible intersections between *AB* and *PPI.* The study will then be presented, aiming to assess *AB* and *PPI* paradigm performance as well as the relationship between the two.

Abstract

The sensorimotor gating mechanism 'gates' sensory stimuli to avoid cognitive overload; a process that can be quantified using the *prepulse inhibition (PPI)* phenomenon. *PPI* measures the attenuation in a startle response following a loud, startling stimulus (*pulse*), when preceded by a weak, non-startling stimulus (*prepulse*). The *attentional blink (AB)* phenomenon, referring to 'inattentional blindness', resulting in an attenuation in the processing of a second target stimulus (T2) when it is preceded by a first target stimulus (T1) within a time period of 200-500ms, might also be underlined by a sensory gating mechanism. Although the two phenomena might result due to the shared or related processes underlying more efficient (and selective) information processing, they have not been investigated previously in relation to one another in meditators. The main aim of the present study was, therefore, to examine the effects of meditation on *AB* (*NAB*, *EAB*) and *PPI* paradigm performance and the relationship between *AB* (*NAB/EAB*) and *PPI*. The relationships of *PPI* with trait *non-reactivity* and *equanimity* were also examined. Given group by sex differences in the *EAB* paradigm performance observed in Study 1, the effects of sex were also explored. All participants (N = 44; Mean age: 43.30$\pm$13.64; Male/Female: 26/18), including 23 meditators (Mean age: 45.83$\pm$13.57; Male/Female: 12/11) and 21 non-meditators (Mean age: 40.52$\pm$13.50, Male/Female: 14/7), completed *PPI, NAB* and *EAB* paradigms, in addition to self-report measures of trait *mindfulness* and *equanimity*. The *PPI* paradigm contained trials with one or two *prepulses* preceding the *pulses*: one-*prepulse* trials had a 120 ms prepulse-to-pulse interval (*PPI*-120) or two-*prepulse* trials with *prepulse-to-pulse* (PRP) intervals of 30 ms (PRP-30) or 120 ms (PRP-120). *AB* paradigms used the lags of 200 ms, 300 ms, 400 ms, 500 ms and 700 ms (*NAB*) and 200 ms, 300 ms, 500 ms and 700 ms *(EAB),* respectively, and were assessed using RA, RT, and *%AB*. *PPI* was indexed by *%PPI*. Stronger *PPI* (i.e. higher *%PPI*) on both PRP-30 and PRP-120 trials was significantly associated with slower T2 RTs in the *NAB* paradigm. *PPI* paradigm performance was not associated with trait *equanimity* or *non-reactivity.* Overall, male meditators identified T2 stimuli faster than male non-meditators in the *EAB* paradigm. No additional sex differences were observed. Although meditation had no impact on *PPI* paradigm performance, associations between *NAB* and *PPI* suggest potentially shared (or similar) underlying mechanisms.

6.1 Introduction

6.1.1 *Sensory Information Processing: Prepulse Inhibition*

As described in Chapter 1 (Section 1.5.2), the sensorimotor gating mechanism as indexed by *PPI* serves to 'gate' (filter) the sensory information from deeper, more complex processing to allow completing the ongoing sensory information processing to protect the limited capacity attention system, to afford selectivity of attention and to avoid information overload (Garcia-Rill et al., 2019), with the *PPI* paradigm providing a quantification of the sensorimotor gating mechanism (Chapter 2, Section 2.3). In summary, *PPI* denotes an attenuation of the startle reflex magnitude when a weak, non-startling stimulus (*prepulse*, to be referred to as P1) precedes a stronger, startling acoustic stimulus (*pulse*, to be referred to as P2) at lead intervals of 30ms-150ms (between P1-to-P2 stimulus onset; Graham, 1975). The sensorimotor gating mechanism underlying the *PPI* effect functions to preserve *prepulse* processing protecting it processing from the disruption by the *pulse*, with the *PPI* therefore being an index of sensory information filtering mechanism enabling efficient sensory information processing (Kumari et al., 2015; Swerdlow et al., 2016).

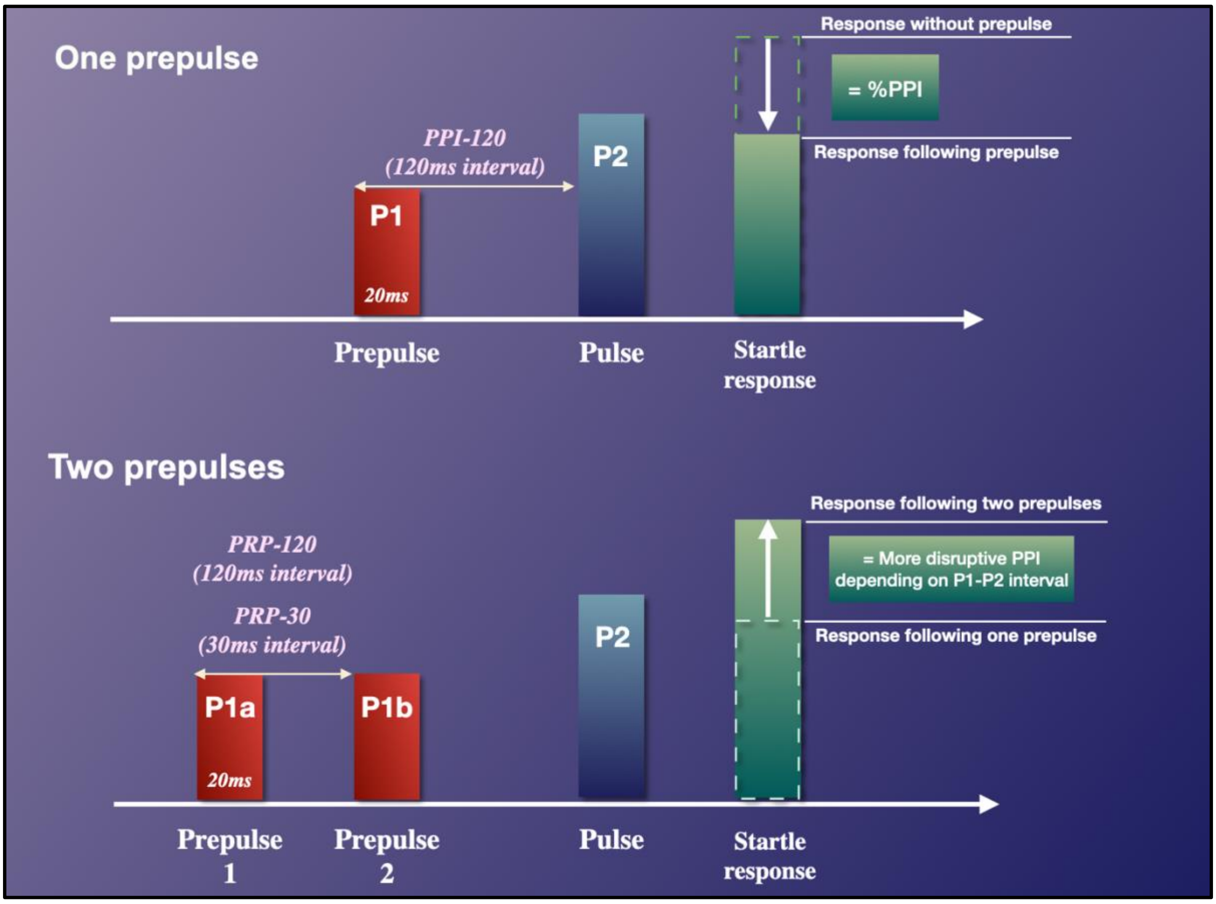
6.1.1.1 *One Prepulse Condition*

In a standard *PPI* trial, a single *prepulse* precedes the *pulse*. The startle response to the *pulse* preceded by a *prepulse* is attenuated compared with the trials in which the *pulse* is presented by itself. It is thought that the information resources are focused towards the processing of P1 so that P2 is perceived as 'less intense' and hence the startle response to P2 is reduced (i.e. this attenuation of startle response denotes stronger *PPI* magnitude or more efficient suppression of the subsequent startle response) (see Chapter 1.5.3 for further details and mechanisms).

6.1.1.2 *Two Prepulse Conditions*

The *pulse* can also be preceded by two *prepulses* (1^{st} and 2^{nd} prepulse, *P1a* and *P1b*, respectively), presented within the 30-120 ms interval. When two *prepulses* are presented before the *pulse*, the startle response to the *pulse* is less attenuated – that is the *PPI* is disrupted, i.e. *PPI* magnitude is lower compared with only one *prepulse* presented before the *pulse* (Kumari et al., 2003; Kumari et al., 2024). This is thought to be due to P1b being attended to at a reduced level, whilst P1a is being processed, thus resulting in weaker inhibition of the startle response to the pulse (Kumari et al., 2024). Figure 6.1 demonstrates relative *PPI* magnitudes for one and two *prepulse* trials.

Figure 6.1. A schematic presentation of the *Prepulse Inhibition (PPI)* trials with one (P1) or two prepulses (P1a and P1b) and the relative startle response to the pulse (P2).



6.1.2 *The Effects of Meditation on Prepulse Inhibition and Attention Regulation*

Typically, meditation training (i.e. trained mindfulness) affords more efficient attentional regulation and enhanced awareness of the sensory, affective, and cognitive elements of the present-moment experience (Brown & Ryan, 2003; Lutz et al., 2008). Mindfulness meditation practice as secularly defined, should, in principle, lead to a flexible engagement of either the mechanisms required for selective attention, including filtering (gating), or more open (less filtered) sensory information processing afforded by more efficient information processing and attentional/cognitive resource allocation. Previous studies investigating the effects of meditation on *PPI* performance, reviewed in detail in Chapter 3 (Section 3.4), reported no *PPI* differences between meditators and non-meditators (Kumari et al., 2015, 2024). No *PPI* effects were observed after a brief mindfulness intervention/ induction (Åsli et al., 2021). However, Kumari et al (2024) reported higher *PPI* levels in a subgroup of meditators who indicated being able to enter non-dual awareness, suggesting ‘deeper’ P1 processing and/or stronger gating in this particular subgroup of meditators. Thus, theoretically, meditation practice might either enhance or attenuate *PPI*, with trait *mindfulness* having either positive or negative associations with *PPI*. The direction of the effects and relationships might also differ depending on a meditation style and/or meditation expertise.

Mindfulness meditation exerts beneficial effects on both sensory processing and cognitive control (Quaglia et al., 2019), with mindfulness meditators having been shown to have a greater attentional capacity for information processing (Slagter et al., 2007). As reviewed in Chapter 3 (Section 3.2), both *NAB* and *EAB* have been found to be attenuated following meditation practice (e.g. Fabio et al., 2018; Makowski et al., 2019; Roca et al., 2023; Sharpe et al., 2021).

6.1.3 *The Link between Prepulse Inhibition and Attentional Blink*

Both the *PPI* and *AB* paradigms are based on intervening temporal periods (‘intervals’ or ‘lags’) between the presentation of a first stimulus (‘*prepulse*’ or ‘T1’) and a second stimulus (‘*pulse*’ or ‘T2’). Further, the diminishing of *PPI* effect over longer time intervals compares to a diminishing *AB* effect at longer lags. Both phenomena are thought to arise from the impact of inhibitory mechanisms that protect the ongoing processing of the first stimulus on the attention to/processing of the subsequent stimulus.

Despite the similarities, at least on the surface level, between the two paradigms and the possible shared mechanisms involving inhibitory processes (as well as *attentional capture* and disengagement), research on the link between *PPI* and *AB* is limited. Only one previous study has directly examined the relationship between *PPI* and *AB* in healthy participants (Cornwell et al., 2006) and confirmed a positive association between *PPI* and *AB* (using an *NAB* paradigm). The study administered *PPI* and *NAB* simultaneously, with findings indicating that higher *PPI* magnitude at T1 target of the *NAB* paradigm was associated with lower T2 accuracy (i.e. stronger *NAB* effects) at lag 300 ms. The authors concluded that whilst *PPI* might index the strength of inhibition/filtering to protect stimuli processing, *AB* effect is related to the *rate of recovery* from the inhibitory processes (Cornwell et al., 2006). This is in line with Raymond et al's (1992) inhibition model (gating) theory of *AB*, suggesting that *AB* is driven by an *inhibitory* mechanism disrupting the processing of T2 (see Chapter 1, Section 1.4.2). Interestingly, Mordkoff & Barth (2001) made a potential link between *PPI* and *attentional* *capture* suggesting that both involve a delay in attention readiness to incoming stimuli whilst attentional system is engaged in processing another salient stimulus. Mordkoff & Barth (2001) therefore suggested the utilisation of *PPI* in studying *attentional capture*. The *AB* and *PPI* thus possibly share the same sensory gating/ filtering mechanism.

Although *AB* is normally studied and observed at the intervals involving conscious attention processing and measured using a voluntary response*, PPI* is an automatic and involuntary process at shorter *prepulse*-to-*pulse* intervals (<60 ms) but more amenable to attention at medium-to-long *prepulse*-to-*pulse* intervals (60-120 ms) (Dawson et al., 1997; Kumari et al., 2015). The *AB*-inducing and medium-to-long *prepulse*-to-*pulse* intervals are also the time periods where stimulus identification and detection typically occur (Dawson et al., 1997). It is possible that mindfulness would attenuate *PPI* via reduced *attentional capture* by the *prepulse* and thus allowing greater attentional/cognitive resources for the processing of the *pulse*, similar to the mechanisms discussed for T1 and T2 stimuli detection/identification in the context of the *AB* paradigm (see Section 1.4.2).

6.1.4 *Aims and Hypotheses*

Following the *AB* model of inhibition (Raymond et al., 1992) and the preliminary finding that *AB* shares inhibitory mechanisms that also drive *PPI* (Cornwell et al., 2006; as detailed in Section 6.1.3), the effects of meditation and the relationship between the two in the same sample of meditators have not been studied previously. The main aims of this study were therefore to assess the relationship between *AB* and *PPI* paradigm performance in meditators and non-meditators, as well as exploring the relationships of *PPI* with trait *equanimity* and *non-reactivity.* The current study extends previous research in three novel ways by investigating the relationships between *AB* and *PPI* in meditators and non-meditators: (i) using both the *NAB* and *EAB* paradigms; (ii) using a single *prepulse* 120-ms interval (as used in Cornwell et al (2006) in non-meditators) and double *prepulse* trials with 30-ms and 120-ms intervals (as used in Kumari et al (2003, 2024); and (iii) using reaction time (RT) and *AB* magnitude (%*NAB/EAB*) as performance indices on the *AB* paradigms. Finally, given that in Study 1 (Chapter 5), sex differences were observed on the *EAB* paradigm performance, the effects of sex (and sex by group) on the *NAB/EAB* and *PPI* paradigm performance were explored.

The study tested the following hypotheses and predictions:

(H1) Meditators, relative to non-meditators, will show significantly attenuated *NAB* (i.e. higher RA in identifying T2 stimuli) at lags 200 ms and/or 300 ms.

(H2) Meditators, relative to non-meditators, will show significantly attenuated *EAB* at lags 200 ms and/or 300 ms.

(H3) Meditators, relative to non-meditators, will show an altered PPI, either significantly enhanced or attenuated.

(H4) There will be a significant correlation of *NAB* and/or *EAB* and *PPI* paradigm performance (%*NAB*/*EAB* and %*PPI*); however, the direction of this relationship could be either positive or negative and could be dependent on the *PPI* interval (30-ms vs 120-ms). %*NAB* was expected to have a stronger relationship with %*PPI* than %*EAB*, given that both the *NAB* and *PPI* paradigms use semantically neutral stimuli (i.e. words and sound probes, respectively). It could be argued, however, that since the *PPI* paradigm involves emotionally salient stimuli (startling sounds that could be perceived as threatening), %*PPI* will also have a relationship with %*EAB*.

The relationships of %*PPI* with trait *equanimity* and *non-reactivity* were also explored, with the direction of the relationships left open. In relation to sex differences, female non-meditators were expected to show weaker *PPI*, relative to male non-meditators, in line with previous studies showing weaker *PPI* in premenopausal females compared with males (e.g. Bannbers et al., 2010; Kumari et al., 2003, 2008).

6.2 Methods

6.2.1 *Participants*

A total of 52 participants, 27 meditators and 25 non-meditators, were recruited and tested for the study. The inclusion criteria for all participants were: (1) aged 18-70 years, (2) fluent in English, (3) with no history of psychiatric or neurological disorders, substance misuse or known cognitive impairment, (4) not regularly maintaining psychoactive medication, (5) not suffering from any hearing impairment, (6) have normal (or corrected-to-normal) vision, and (7) not consuming >28 units of alcohol per week or >6 units of caffeinated beverages a day. For meditators, an additional inclusion criterion included practicing meditation for ≥ 20mins a day, 5 days a week, for at least 1 year.

To recruit non-meditators, the study was advertised using the posters in the local area and on the Brunel University campus, as well as through online platforms. Meditators were recruited from the database maintained by Dr Elena Antonova as well as the National Mindfulness centre using the poster advertising the study.

One meditator was excluded from the data analysis due to ambiguity in meditation experience/ incomplete meditation history, one meditator was excluded due to noisy psychophysiological data (see Section 6.2.6 for more details), two participants (1 meditator, 1 non-meditator) were excluded due to incomplete data on the *NAB* paradigm, and a further four participants (1 meditator, 3 non-meditators) were excluded due to being identified as outliers on the *NAB*/*EAB* paradigms (according to the exclusion criteria for random responding outlined in Chapter 5, Section 5.3.5).

The final analysed sample included 44 healthy participants (Mean age = 43.30; SD = 13.64; age range = 24-70, Male/Female = 26/18): 23 meditators and 21 age- and sex-matched non-meditators. The current study used a subsample of Kumari et al (2024), with only those participants included in the final analysed sample who had complete data for the *NAB* and *EAB* paradigms. Following the same approach as in Study 1 (Chapter 5, Section 5.2.1), meditators were split into two subgroups based on meditation tradition: Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT) (Chapter 5, Section 5.2.1, provides further details on the groups' categorisation strategy). In Study 2, MaSD group consisted of Secular Mindfulness as taught within MBSR/MBCT, Samatha, Open Presence/Tibetan and Vipassana; OMT group included the practitioners of Theravada, Raj Yoga Meditation, Inner Yoga and Mantra recitation.

6.2.2 *Design and Procedures*

All participants were tested on a single occasion in a psychophysiology lab at the Brunel University of London. The study utilised a between-group design to investigate group differences between meditators and non-meditators in *NAB/EAB and PPI* paradigm performance. A correlational design was utilised to examine the relationships of *NAB/ EAB* with *PPI* paradigm performance.

The participants were assessed on the *PPI* paradigm first, followed by a break, before completing the *NAB* and *EAB* paradigms. A researcher was present in the laboratory at all times. All participants completed self-report measures of trait *mindfulness* and *equanimity*, with breaks as required. Meditators were also requested to complete the Meditation History Questionnaire (MHQ), as used in previous studies (Antonova et al., 2015; Kumari et al., 2024) to provide information on their previous meditation experience (i.e. meditation tradition/styles of practice, total years of practice, daily practice routine and other practice-related information). The MHQ version used in this study was a brief version of the MHQ used in Study 1 in consideration of the overall duration of a lab-based testing session (See Supplementary Materials, Appendix B, Figure B).

All participants provided written informed consent after receiving information on the study's aims and procedures, and were compensated for their time (£30 Amazon voucher) and travel. The study was approved by the College of Health, Medicine and Life Sciences Research Ethics Committee of Brunel University London (Reference: 12411-LR-Nov/2018-15029-2).

6.2.3 *Neutral Attentional Blink and Emotional Attentional Blink Paradigms*

The same *NAB* and *EAB* paradigms were used in this study as in Study 1, the detailed description of which can be found in Chapter 5 (Section 5.3.3). In summary, both paradigms consisted of the Rapid Serial Visual Presentation (RSVP) stream of two target stimuli (T1 and T2) and distractors. In the *NAB* paradigm, the targets were digits, separated by letters that were distractors with five inter-stimuli intervals (lags of 200 ms, 300 ms, 400 ms, 500 ms and 700 ms); in the *EAB* paradigm, the targets were words, separated by a stream of distractor words with inter-stimuli intervals (lags of 200 ms, 300 ms, 500 ms, and 700 ms) . The *EAB* paradigm consisted of a *neutral* (neutral T1, neutral T2) and *emotional* (emotional T1, neutral T2) conditions.

6.2.4 *Prepulse Inhibition Paradigm*

The *PPI* paradigm, data collection and scoring procedures were identical to those described by Kumari et al (2024). The *prepulse* and *pulse* stimuli were the bursts of 84-dB (A) white noise of 20-ms duration and 114-dB (A) white noise of 40-ms duration, respectively; both were presented over 70-dB (A) continuous background white noise. There were 37 trials altogether, with the first trial being a *pulse-alone* trial, which was not included in the analysis. The remaining 36 trials were arranged into three blocks (12 trials each). In each block, there were three '*pulse-alone'* trials, three *PPI*-120 trials [a *single* distinct *'prepulse' (P1)* with a 120-ms prepulse-to-pulse (PRP; onset-to-onset)] and in the remaining six trials *second* distinct *'prepulse' (P1b)* was presented after the *initial 'prepulse' (P1a),* with a 30-ms (PRP-30) or 120-ms interval (PRP-120) between the two *prepulses* (onset-to-onset) (see Figure 6.1). The average inter-trial-interval (ITI) was 15s, ranging between 9-23s. The experiment began with a 2-minutes acclimatisation period during which 70-dB (A) continuous white noise was presented. All acoustic stimuli were presented binaurally via headphones worn by the participants. The experiment lasted approximately 11 minutes.

Electromyographic (EMG) recordings were acquired in a psychophysiology laboratory whilst participants were sitting comfortably in a chair, requested to stay relaxed and to keep their eyes open throughout the duration of the experiment. EMG activity of the orbicularis oculi muscle was recorded to measure the eye-blink startle responses (as described in Chapter 2, Section 2.3). Three miniature silver/silver chloride electrodes were filled with Dracard electrolyte paste (SLE, Croydon, UK); one electrode was attached behind the right ear on the mastoid process (ground electrode) and the additional two electrodes were positioned directly underneath the right eye. A computerised, human startle response monitoring system (SR-LAB, San Diego, California) was used to deliver the acoustic startle stimuli, as well as to record and to score the EMG activity of the ocular orbitalis muscle (eye blink reflex) following startling stimuli *(pulses).* Following guidelines of the SR-LAB, recorded EMG activity was band-filtered: analogue bandpass filtering emerged before digitising, 50-Hz interference was filtered through a 50-Hz notch filter, and cut-off frequencies for low-pass and high-pass were set at 1000 Hz and 100 Hz, respectively. The amplification gain control for EMG signal was maintained throughout the whole study.

6.2.5 *Self-Report Measures*

6.2.5.1 *Trait Mindfulness and Equanimity*

Trait mindfulness and *equanimity* were assessed using the Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) and the Non-Attachment Scale (NAS-7; Sahdra et al., 2016), respectively. A detailed description of the FFMQ and NAS-7 is provided in Study 1 (Chapter 5, Section 5.2.4.1). The FFMQ in the current sample for *Observing, Describing, Acting with Awareness, Non-Judging,* and *Non-Reactivity* showed a Cronbach's α of .84, .89, .89, .90, .76, respectively. NAS-7 showed a Cronbach's α of .72.

6.2.5.2 *Self-Report Data Reliability*

To ensure reliability of self-report data, two attention checks (in the form of repeated *catch* items) were included to check random responding by assessment of scoring consistency for FFMQ (items 7 and 29). Further details on how similarity checks were conducted are stated in Study 1 (Chapter 5, Section 5.2.4.2).

6.2.6 *Statistical Analysis*

All analyses were completed using IBM SPSS Statistics, version 29.0 (SPSS Inc., Chicago, IL), with alpha level for significance testing of effects set at $p \leq .05$. Assumptions of normality were tested using the Shapiro-Wilk test.

For the *NAB/EAB* paradigms, raw *NAB* and *EAB* data were processed (as described in Study 1, Chapter 5, Section 5.2.5) blind to the group identity. *AB* performance was indexed using Response Accuracy (RA) and Reaction Time (RT) to correct responses (as in Chapter 5, Section 5.2.5), separately for T1 and T2 and per lag. *NAB* and *EAB* magnitude (*%NAB* and *%EAB*) were also calculated per lag to quantify *AB*, with higher *%AB* denoting a stronger *AB* effect (i.e., reduced accuracy). The formula is presented in Study 1 (Chapter 5, Section 5.2.5).

For the *PPI* paradigm, raw EMG data were processed blind to group identification and offline via an accompanying analytic programme for startle response amplitude to *pulse-alone* trials (through Analog-to-Digit units). EMG data were examined trial-by-trial, per participant, prior to scoring. Trials with noisy data (i.e. no clear eye blinks within 20-120ms of the pulse, <10% in total) and participants with noisy data, or no clear blinks on >50% of trials were excluded (1 excluded participant; see Section 6.3.1 *Participants*). *PPI* magnitude (*%PPI)* was quantified for *PPI*-120, PRP-30 and PRP-120 trials using the following formula (higher *%PPI* denotes a stronger *PPI* effect):

$$\% \, PPI = \left(\frac{Amplitude \; on \; 'Pulse - alone' \; Trials - Amplitude \; on \; PPI/PRP \; Trials}{Amplitude \; on \; 'Pulse - alone' \; trials} \right) x \;\; 100$$

6.2.6.1 *Sample Characteristics*

Group- and sex-related differences in age and self-report measures (FFMQ, NAS-7) were analysed using 2 (Group: Meditators, Non-meditators) x 2 (Sex: Male, Female) analysis of variance (ANOVA). MaSD and OMT meditator subgroups were compared on age, meditation practice history and the self-report measures using the Mann-Whitney U-test (non-parametric) due to the small sample size of the OMT subgroup (n = 6).

6.2.6.2 *NAB and EAB Paradigms*

To test H1, differences between meditators and non-meditators in *NAB* paradigm performance (RA and RT) were assessed using a 2 (Target Position: T1, T2) x 5 (Lag: 200 ms, 300 ms, 400 ms, 500 ms, 700 ms) x 2 (Group: Meditators, Non-meditators) x 2 (Sex: Male, Female) repeated measures ANOVA (rmANOVA), with Target Position and Lag as within-subject factors, and Group and Sex as between-subject factors. To test H2, differences between meditators and non-meditators in *EAB* performance (RA and RT) were assessed using a 2 (Target Position: T1, T2) x 2 (Condition: Neutral, Emotional) x 4 (Lag: 200 ms, 300 ms, 500 ms, 700 ms) x 2 (Group: Meditators, Non-meditators) x 2 (Sex: Male, Female) rmANOVA, with Target Position, Condition and Lag as within-subject factors, and Group and Sex as between-subject factors.

All significant main effects or interactions were followed up by lower-order rmANOVAs and between-and/or within-subject pair-wise comparisons, as relevant. Effect sizes, where reported, were partial eta squared (η_p^2). For all factors involved in the rmANOVA, the assumption of sphericity was tested using the Mauchly's test and a Greenhouse-Geisser correction was applied where the assumption of sphericity was violated. The *alpha* level for the planned lower-level rmANOVAs and pair-wise comparisons to further investigate significant interactions as per H1-H2 testing (i.e. involving Group at lags 200 ms and/or 300 ms) was maintained at .05 (p <.05) to avoid committing Type II error. The *alpha* level for the post-hoc analyses of the interactions that were not predicted was set at .01 (p <. 01) to adjust for multiple tests to minimise committing Type I error.

6.2.6.3 *PPI Paradigm*

To test H3, response amplitude over pulse-alone stimuli was analysed using a 3 (Block: Blocks 1-3, with each block representing the average of valid responses to three pulse-alone stimuli) x 2 (Group) x 2 (Sex) rmANOVA, with Block as the within-subjects factor, and Group and Sex as the between-subjects factors. Then, to assess possible differences between the meditators and non-meditators in *PPI* performance, a 3 (Trial Type: *PPI*-120, PRP-30, PRP-120) x 2 (Group) x 2 (Sex) rmANOVA was conducted, with Trial Type as a within-subjects factor, and Group and Sex as between-subjects factors. The assumption of sphericity was checked, and the Greenhouse-Geisser correction applied where needed.

6.2.6.4 *Relationships of NAB and EAB with PPI Paradigm Performance*

To test H4, Spearman's *rho* correlation coefficients were used to examine the relationship of %*PPI* with *NAB* (RT, *%NAB*) and *EAB* (RT, *%EAB*) using correlational analyses in the whole sample, meditator and non-meditator groups, and meditation subgroups (MaSD, OMT). *%NAB, %EAB*, *%PPI* and *EAB* RT data were not normally distributed. Partial correlations were performed for any significant associations between *%PPI* and T2 RT in the *NAB/ EAB* paradigms to control for T1 RT. As exploratory analysis, Spearman's *rho* correlation coefficients were used to investigate the relationships of *%PPI* with FFMQ *non-reactivity* and NAS-7 *equanimity* scores. The *alpha* level for the correlations as per H4-testing was maintained at .05 (p < .05) to avoid committing Type II error. The *alpha* level for the correlations that were exploratory/not predicted was set at .01 (p <. 01) to adjust for multiple tests to minimise committing Type I error.

6.3 Results

6.3.1 *Sample Characteristics*

Meditator and non-meditator groups did not differ significantly in age [$F_{1, 40} = 1.30$, $p = .26$, $\eta_p^2 = .031$]. There was no Sex effect, or Group x Sex interaction in age (Table 6.1).

The main effect of Group was significant for the FFMQ *total* (excluding *Observing*) scores [$F_{1, 40} = 17.11$, $p < .001$, $\eta_p^2 = .300$] with higher scores in meditators, relative non-meditators (Table 6.1). Further ANOVAs on the FFMQ subscale scores revealed a highly significant main effect of Group for *Observing* [$F_{1, 40} = 22.33$, $p < .001$, $\eta_p^2 = .358$], *Describing* [$F_{1, 40} = 6.95$, $p = .012$, $\eta_p^2 = .148$], *Acting with Awareness* [$F_{1, 40} = 14.48$, $p < .001$, $\eta_p^2 = .266$] and *Non-reactivity* [$F_{1, 40} = 10.53$, $p = .002$, $\eta_p^2 = .208$], indicating higher scores in the meditators group, as expected; *Non-judging* subscale failed to show a significant group difference [$F_{1, 40} = 2.48$, $p = .123$, $\eta_p^2 = .058$]. There was also a main effect of Sex for *Acting with Awareness* [$F_{1, 40} = 7.60$, $p = .009$, $\eta_p^2 = .160$], with higher scores in males than females. There were no additional significant Sex effects or any Group x Sex interactions for FFMQ *total* or subscale scores (Table 6.1).

Only a small sample of participants (n = 15) completed the NAS-7. There were no Group effects, or Group x Sex interactions in NAS-7 scores (Table 6.1).

There were no significant differences in age between MaSD and OMT meditator subgroups (Table 6.2). MaSD group scored significantly lower than OMT group on FFMQ *Acting with Awareness* [$U = 2.07$, $p = .04$]. There were no significant differences between the meditation subgroups on FFMQ *total*, other FFMQ subscale scores or NAS-7 scores (Table 6.2). Given the small size of the OMT subgroup (n = 6), the meditation subgroups are only used to characterise the meditator sample in relation to Study 1; the two subgroups were not used in any of the data analyses.

6.3.2 *Meditation Practice Indices*

Three indices were calculated to quantify meditators' practice experience: (i) Total Years of Regular Practice (YoP), (ii) Total Hours of Regular Practice (HoP) and (iii) Intensity of Regular Practice (IoP) (for the details of the calculations see Chapter 5 (Section 5.3.2). Meditators had a total YoP of 15.72 years (SD = 12.73, range = 1.50-52) and a total HoP of 4522.27 hours (SD

= 6275.07, range = 121.33-28392) on average (Table 6.2). OMT group scored significantly higher than MaSD group on the IoP index [U = 2.73, p = .004], signifying more intensive regular practice routine in OMT meditators. The subgroups did not differ on the YoP or HoP indices (Table 6.2).

Table 6.1. Demographic characteristics and self-reported trait *mindfulness* and *equanimity* for the whole sample, Meditator and Non-meditator groups.

Demographics	**Whole Sample (N = 44)**		**Meditators (N = 23)**		**Non-meditators (N = 21)**		**Group Difference**
	Mean *(SD)*	Range	Mean *(SD)*	Range	Mean *(SD)*	Range	$F_{1,40}$ (p-value)
Age							
Male	40.50 *(13.99)*	24-70	42.08 (*15.53*)	24 – 67	39.14 (*12.96*)	26 – 70	.19
Female	47.33 *(12.41)*	29-68	49.91 (*10.22*)	34 – 62	43.29 (*15.19*)	29 – 68	(.66)
Total	43.30 *(13.64)*	24-70	45.83 (*13.57*)	24 – 67	40.52 (*13.50*)	26 – 70	
FFMQ	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	$F_{1,40}$ (p-value)
Total (Without Observing)							
Male	113.38 *(15.27)*	90-152	122.17 (*16.30*)	90 – 152	105.86 (*9.57*)	90 – 129	.09
Female	113.78 *(16.84)*	74-144	121.09 (*12.30*)	102 – 144	102.29 (*17.30*)	74 – 122	(.77)
Total	113.55 *(15.74)*	74-152	121.65 (*14.21*)	90-152	104.67 (*12.34*)	74 – 129	
Observing							
Male	28.69 *(5.48)*	19-37	31.67 (*4.36*)	22 – 37	26.14 (*5.14*)	19 – 36	1.39
Female	29.33 *(6.89)*	13-40	32.91 (*3.78*)	29 – 40	23.71 (*7.11*)	13 – 33	(.25)
Total	28.95 *(6.03)*	13-40	32.26 *(4.05)*	22 – 40	25.33 (*5.81*)	13 – 36	
Describing							
Male	29.96 *(5.87)*	18-40	31.92 (*6.29*)	18 – 40	28.29 (*5.12*)	20 – 36	.26
Female	30.72 *(5.71)*	19-40	32.82 (*4.77*)	27 – 40	27.43 (*5.80*)	19 – 38	(.61)
Total	30.27 *(5.74)*	18-40	32.35 *(5.51)*	18 – 40	28.00 (*5.22*)	19 – 38	
Acting with Awareness							
Male	30.77 *(5.51)*	20-40	33.00 (4.79*)*	26 – 40	28.86 (*5.52*)	20 – 38	1.18
Female	27.56 *(5.67)*	14-37	30.45 (*3.64*)	24 – 37	23.00 (*5.42*)	14 – 30	(.28)
Total	29.45 *(5.74)*	14-40	31.78 *(4.38)*	24 – 40	26.90 (*6.05*)	14 – 38	
Non-Judging							
Male	28.35 (*7.16)*	15-39	30.83 (*8.00*)	17 – 39	26.21 (*5.82*)	15 – 36	.39
Female	31.22 *(6.38)*	20-40	32.00 (*5.57*)	21 – 40	30.00 (*7.79*)	20 – 39	(.54)
Total	29.52 *(6.92)*	15-40	31.39 *(6.81)*	17 – 40	27.48 (*6.60*)	15 – 39	
Non-Reactivity							
Male	24.31 *(4.23)*	16-35	26.42 (*4.70*)	16 – 35	22.50 (*2.85*)	17 – 27	.00
Female	24.28 *(4.38)*	12-30	25.82 (*3.16*)	21 – 30	21.86 (*5.15*)	12 – 28	(.99)
Total	24.30 *(4.24)*	12-35	26.13 (*3.96*)	16 – 35	22.29 (*3.65*)	12 – 28	
NAS-7	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	$F_{1,11}$ (p-value)
NAS-7 Equanimity							
Male	37.14 *(4.06)*	32-42	39.50 *(3.32)*	35-42	34.00 *(2.65)*	32-37	.10
Female	35.38 *(6.02)*	26-42	36.80 *(6.42)*	26-42	33.00 *(5.57)*	28-39	(.75)
Total	36.20 *(5.10)*	26-42	38.00 *(5.17)*	26-42	33.50 *(3.94)*	28-39	

Table 6.2. Meditation experience index, demographic characteristics and self-reported trait *mindfulness* and *equanimity* for Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT) groups

Measure	MaSD (N = 17)	OMT (N = 6)	Group Difference (N = 23)
	Mean *(SD)*	Mean *(SD)*	U (*p*-value)
Age	47.59 *(12.27)*	40.83 *(16.96)*	-1.05 (.32)
Meditation Experience Index			
Total Years of Regular Practice	15.38 *(10.82)*	16.67 *(18.35)*	-.28 (.81)
Total Hours of Regular Practice	3220.65 *(3472.71)*	8210.22 *(10610.58)*	1.02 (.32)
Intensity of Regular Practice	-2393.91 *(2183.64)*	2126.89 *(4030.50)*	2.73 **(.004)**
FFMQ			
Observing	32.59 *(4.17)*	31.33 *(3.88)*	-.81 (.43)
Describing	32.65 *(4.94)*	32.50 *(7.37)*	.11 (.92)
Acting with Awareness	30.53 *(3.57)*	35.33 *(4.80)*	2.07 **(.04)**
Non-Judging	30.76 *(6.25)*	33.17 *(8.61)*	1.02 (.32)
Non-Reactivity	25.94 *(3.65)*	26.67 *(5.09)*	-.07 (.97)
Total without Observing	119.88 *(13.52)*	126.67 *(16.22)*	.88 (.39)
NAS-7			
NAS-7 Equanimity	39.40 *(2.19)*	36.25 *(7.59)*	-.25 (.91)

* 0 is the cut off point for moderate practice as defined by the Intensity of Practice (IoP) criterion and the formula used to calculate it, i.e. the IoP values equal to or below 0 indicate moderate practice (defined as at least 1 hour once a day over the years of practice), the IoP values above 0 indicate intensive practice

6.3.3 *Neutral Attentional Blink Performance*

6.3.3.1 *Response Accuracy (RA)*

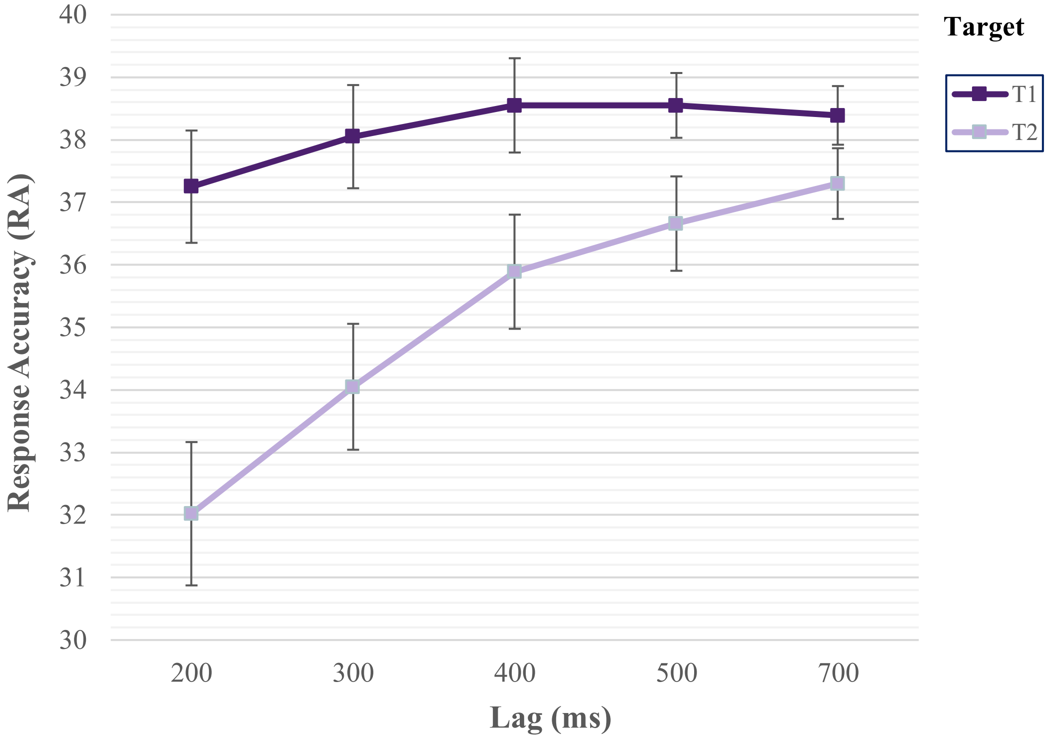
The main effect of Target Position [$F_{1, 40} = 72.18$, p <.001, $\eta_p^2 = .643$], Lag [$F_{2.1, 82.5} = 22.4$, p <.001, $\eta_p^2 = .359$] and Target Position x Lag interaction [$F_{2.6, 102.1} = 27.6$, p <.001, $\eta_p^2 = .408$] were significant, with all pairwise comparisons between lags being significant ($p < .001$) for T2 RA, with T2 RA being significantly lower at shorter lags, relative to longer lags (Table 6.3, Figure 6.2). No main effect of Group or any interactions with Group (or Sex) were found (Table 6.3).

6.3.3.2 *Reaction Time (RT)*

The main effect of Target Position [$F_{1, 40} = 345.4$, p <.001, $\eta_p^2 = .896$], Lag [$F_{2.5, 98.6} = 7.21$, p <.001, $\eta_p^2 = .153$] and Target Position x Lag interaction [$F_{3.1, 122} = 13.7$, p <.001, $\eta_p^2 = .255$]

were significant, with pairwise comparisons between lags showing that T2 RT was faster than T1 RT across all lags (*p* <.001). There was no main effect of Group or any significant Group interactions (Table 6.3).

Figure 6.2. T1 and T2 Response Accuracy (RA) in the *Neutral Attentional Blink (NAB)* paradigm.



Error bars represent +/- 2 standard error of the mean.

Table 6.3. Mean (SD) Response Accuracy (RA) and Reaction Time (RT) indices for T1 and T2 target position in the *Neutral Attentional Blink (NAB)* paradigm at lags 200 ms, 300 ms, 400 ms, 500 ms, and 700 ms for Non-meditator and Meditator groups, as well as the inferential statistics for the results of the 2 (Group) x 2 (Sex) x 2 (Target Position) x 5 (Lag) rmANOVAs.

NAB	Lag (ms)	Target Position	Non-meditators (N = 21) Mean (SD)	Meditators (N = 23) Mean (SD)	Main Effects	Interactions
Response Accuracy (RA)	200	T1	37.10 (8.15)	37.39 (3.00)	**Target Position:** $F_{1, 40} = 72.18$, $\boldsymbol{p} < .001$, $\eta_p^2 = .643$	**Target Position x Group:** $F_{1, 40} = 1.47$, $p = .23$, $\eta_p^2 = .035$ **Target Position x Group x Sex:** $F_{1, 40} = .08$, $p = .78$, $\eta_p^2 = .002$
		T2	32.67 (8.70)	31.43 (6.58)	**Lag:** $F_{2.1, 82.5} = 22.4$, $\boldsymbol{p} < .001$, $\eta_p^2 = .359$	
	300	T1	37.76 (7.78)	38.30 (1.82)	**Group:** $F_{1, 40} = .002$, $p = .97$, $\eta_p^2 = .00$	**Lag x Group:** $F_{2.1, 82.5} = .74$, $p = .48$, $\eta_p^2 = .018$ **Lag x Group x Sex:** $F_{2.1, 82.5} = .62$, $p = .55$, $\eta_p^2 = .015$
		T2	34.62 (7.94)	33.52 (5.42)		
	400	T1	37.95 (7.12)	39.09 (1.47)	**Sex:** $F_{1, 40} = .01$, $p = .91$, $\eta_p^2 = .00$	**Target Position x Lag:** $F_{2.6, 102.1} = 27.6$, $\boldsymbol{p} < .001$, $\eta_p^2 = .408$ **Target Position x Lag x Group:** $F_{2.6, 102.1} = 1.47$, $p = .23$, $\eta_p^2 = .035$ **Target Position x Lag x Group x Sex:** $F_{2.6, 102.1} = 1.53$, $p = .22$, $\eta_p^2 = .037$
		T2	36.33 (7.66)	35.48 (4.24)		
	500	T1	38.00 (4.78)	39.04 (1.33)		
		T2	36.33 (6.48)	36.96 (3.25)		
	700	T1	38.24 (4.11)	38.52 (1.88)		
		T2	37.19 (4.72)	37.39 (2.68)		
Reaction Time (RT)	200	T1	1.30 (.30)	1.33 (.33)	**Target Position:** $F_{1, 40} = 345.4$, $\boldsymbol{p} < .001$, $\eta_p^2 = .896$	**Target Position x Group:** $F_{1, 40} = 1.02$, $p = .32$, $\eta_p^2 = .025$ **Target Position x Group x Sex:** $F_{1, 40} = .74$, $p = .40$, $\eta_p^2 = .018$
		T2	.59 (.20)	.57 (.23)	**Lag:** $F_{2.5, 98.6} = 7.21$, $\boldsymbol{p} < .001$, $\eta_p^2 = .153$	
	300	T1	1.24 (.37)	1.26 (.34)	**Group:** $F_{1, 40} = .006$, $p = .94$, $\eta_p^2 = .00$	**Lag x Group:** $F_{2.5, 98.6} = .12$, $p = .92$, $\eta_p^2 = .003$ **Lag x Group x Sex:** $F_{2.5, 98.6} = .15$, $p = .90$, $\eta_p^2 = .004$
		T2	.53 (.19)	.50 (.16)		
	400	T1	1.21 (.41)	1.21 (.31)	**Sex:** $F_{1, 40} = .04$, $p = .84$, $\eta_p^2 = .001$	**Target Position x Lag:** $F_{3.1, 122} = 13.7$, $\boldsymbol{p} < .001$, $\eta_p^2 = .255$ **Target Position x Lag x Group:** $F_{3.1, 122} = .16$, $p = .93$, $\eta_p^2 = .004$ **Target Position x Lag x Group x Sex:** $F_{3.1, 122} = .75$, $p = .53$, $\eta_p^2 = .018$
		T2	.59 (.21)	.54 (.16)		
	500	T1	1.15 (.31)	1.18 (.33)		
		T2	.60 (.23)	.55 (.20)		
	700	T1	1.14 (.29)	1.14 (.28)		
		T2	.57 (.20)	.55 (.19)		

6.3.4 *Emotional Attentional Blink Performance*

6.3.4.1 *Response Accuracy (RA)*

There was a significant main effect of Target Position [$F_{1, 40}$ = 214.9, *p* <.001, η_p^2 = .843], Lag [$F_{2.4, 94.1}$ = 44.8, *p* <.001, η_p^2 = .53] and a significant Target Position x Lag interaction [$F_{2.4, 94.9}$ = 75.0, *p* <.001, η_p^2 = .652], with T2 RA being significantly lower at shorter lags compared with longer lags (all pairwise comparisons between lags being significant at *p <.001;* Table 6.4). Target Position x Condition interaction was also significant [$F_{1, 40}$ = 13.8, *p* <.001, η_p^2 = .256], with pairwise comparisons showing that T1 RA was significantly higher in the *emotional* than the *neutral* condition (*p = .004*). The interaction of Target Position x Condition x Lag showed T2 RA to be significantly lower than T1 RA across *neutral* and *emotional* conditions for all lags (*p <.001*).

Although the main effect of Group was not significant, there was a significant Lag x Group x Sex [$F_{2.4, 94.1}$ = 7.25, *p* <.001, η_p^2 = .153] interaction (Table 6.4). Follow-up lower-order ANOVAs in meditators and non-meditators revealed that the interaction was driven by a significant Lag x Sex interaction in non-meditators [$F_{3, 57}$ = 6.51, *p* <.001, η_p^2 = .255], with female non-meditators showing a strong Lag effect (i.e. progressively higher accuracy from shorter to longer lags [$F_{3, 18}$ = 29.61, *p* <.001, η_p^2 = .831], there was no lag effect in male non-meditators (i.e. no significant differences between shorter and longer lags). Pairwise comparisons showed significantly higher accuracy at longer lags than shorter lags across all lags (*p <.001*). There were no additional Group interactions (Table 6.4).

6.3.4.2 *Reaction Time (RT)*

The main effect of Target Position [$F_{1, 32}$ = 26.6, *p* <.001, η_p^2 = .454], Lag [$F_{1.9, 59.6}$ = 11.6, *p* <.001, η_p^2 = .266] and Target Position x Lag [$F_{1.8, 56.3}$ = 10.2, *p* <.001, η_p^2 = .243] interaction were significant (Table 6.4), explained by T2 RT being faster at lag 200 ms (*p <.001*) and lag 300 ms (*p = .005)* but slower at lag 700 ms (*p <.001*) compared to T1 RT. The interaction of Target Position x Condition was marginally significant [$F_{1, 32}$ = 3.46*, p = .07*, η_p^2 = .097] with slower RTs to the *emotional* relative to the *neutral* T1 condition (*p <.001*).

The main effect of group was not significant, however, there was a significant Target Position x Group x Sex interaction [$F_{1, 32}$ = 4.82, *p* = .036, η_p^2 = .131]. Follow-up lower-order ANOVAs in males and females revealed a significant Target Position x Group interaction in males [$F_{1, 20}$

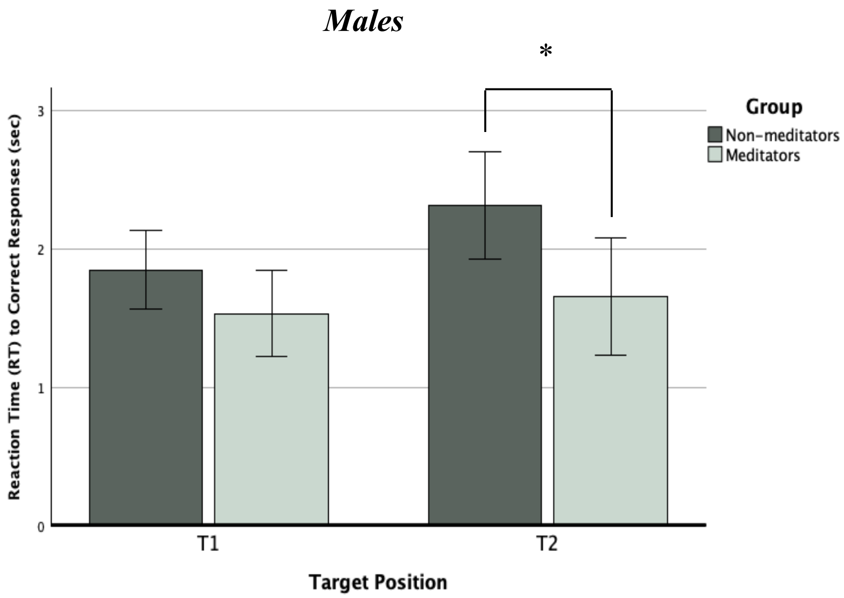
= 4.70, p = .042, η_p^2 = .190]. Following pairwise comparisons, male non-meditators showed slower RTs to T2 identification than male meditators (p = *.047;* Figure 6.3). No additional Group interactions were reported (Table 6.4).

Table 6.4. Mean (SD) Response Accuracy (RA) and Reaction Time (RT) indices for T1 and T2 target position in the *Emotional Attentional Blink (EAB)* paradigm at lags 200 ms, 300 ms, 500 ms, and 700 ms for Non-meditator and Meditator groups, as well as the inferential statistics for the results of the 2 (Group) x 2 (Sex) x 2 (Target Position) x 2 (Condition) x 4 (Lag) rmANOVAs.

EAB	Lag (ms)	Target Position	Non-meditators (N = 21) Mean (SD)	Meditators (N = 23) Mean (SD)	Main Effects	Interactions
Response Accuracy (RA)	200	T1	13.24 (2.88)	13.35 (2.53)	**Target Position** $F_{1, 40}$ = 214.9, ***p* <.001**, η_p^2 = .843	**Target Position x Group:** $F_{1, 40}$ = .25, *p* = .62, η_p^2 = .006 **Target Position x Group x Sex:** $F_{1, 40}$ = .20, *p* = .66, η_p^2 = .005
		T2	5.43 (3.56)	5.48 (3.72)	**Condition:** $F_{1, 40}$ = .90, *p* = .35, η_p^2 = .022	**Condition x Group:** $F_{1, 40}$ = 1.14, *p* = .29, η_p^2 = .028
	300	T1	13.48 (2.50)	12.87 (2.65)	**Lag:** $F_{2.4, 94.1}$ = 44.8, ***p* <.001**, η_p^2 = .53	**Condition x Group x Sex:** $F_{1, 40}$ = .53, *p* = .47, η_p^2 = .013
Neutral condition		T2	6.71 (4.63)	6.09 (4.53)	**Group:** $F_{1, 40}$ = .05, *p* = .82, η_p^2 = .001	**Lag x Group:** $F_{2.4, 94.1}$ = 1.0, *p* = .38, η_p^2 = .024 **Lag x Group x Sex:** $F_{2.4, 94.1}$ = 7.25, ***p* <.001**, η_p^2 = .153
	500	T1	13.05 (3.11)	13.52 (2.56)	**Sex:** $F_{1, 40}$ = .39, *p* = .54, η_p^2 = .010	**Target Position x Condition:** $F_{1, 40}$ = 13.8, ***p* <.001**, η_p^2 = .256
		T2	9.24 (4.05)	8.74 (4.35)		**Target Position x Condition x Group:** $F_{1, 40}$ = .57, *p* = .46, η_p^2 = .014 **Target Position x Condition x Group x Sex:** $F_{1, 40}$ = .05, *p* = .82, η_p^2 = .001
	700	T1	12.43 (2.98)	12.70 (2.90)		**Target Position x Lag:** $F_{2.4, 94.9}$ = 75.0, ***p* <.001**, η_p^2 = .652
		T2	9.57 (4.02)	9.39 (4.49)		**Target Position x Lag x Group:** $F_{2.4, 94.9}$ = .20, *p* = .86, η_p^2 = .005 **Target Position x Lag x Group x Sex:** $F_{2.4, 94.9}$ = 1.75, *p* = .17, η_p^2 = .042
Response Accuracy (RA)	200	T1	13.38 (2.56)	13.39 (2.81)		
		T2	5.57 (3.27)	5.30 (3.47)		**Condition x Lag:** $F_{3, 120}$ = 4.69, ***p* = .004**, η_p^2 = .105 **Condition x Lag x Group:** $F_{3, 120}$ = .68, *p* = .57, η_p^2 = .017
	300	T1	13.71 (2.37)	13.87 (2.26)		**Condition x Lag x Group x Sex:** $F_{3, 120}$ = .29, *p* = .83, η_p^2 = .007
Emotional condition		T2	6.48 (4.16)	5.04 (3.87)		**Target Position x Condition x Lag:** $F_{3, 120}$ = 4.52, ***p* =.005**, η_p^2 = .101 **Target Position x Condition x Lag x Group:** $F_{3, 120}$ = 1.50, *p* = .22, η_p^2 = .036
	500	T1	13.33 (2.78)	13.91 (2.63)		**Target Position x Condition x Lag x Group x Sex:** $F_{3, 120}$ = 1.13, *p* = .34, η_p^2 = .027
		T2	7.52 (4.84)	8.22 (4.90)		
	700	T1	12.95 (2.78)	14.00 (1.98)		
		T2	10.38 (3.93)	10.74 (4.37)		

EAB	Lag (ms)	Target Position	Non-meditators (N = 21) Mean (SD)	Meditators (N = 23) Mean (SD)	Main Effects	Interactions
Reaction Time (RT) *Neutral* condition	200	T1	1.86 (.56)	1.85 (.38)	**Target Position:** $F_{1, 32} = 26.6$, **p <.001**, $\eta_p^2 = .454$	**Target Position x Group:** $F_{1, 32} = .83$, $p = .37$, $\eta_p^2 = .025$ **Target Position x Group x Sex:** $F_{1, 32} = 4.82$, **p = .036**, $\eta_p^2 = .131$
		T2	2.57 (1.04)	2.32 (1.0)	**Condition:** $F_{1, 32} = .11$, $p = .75$, $\eta_p^2 = .003$	**Condition x Group:** $F_{1, 32} = .48$, $p = .49$, $\eta_p^2 = .015$ **Condition x Group x Sex:** $F_{1, 32} = .12$, $p = .73$, $\eta_p^2 = .004$
	300	T1	1.76 (.54)	1.83 (.56)		
		T2	1.93 (.70)	2.09 (.77)	**Lag:** $F_{1.9, 59.6} = 11.6$, **p <.001**, $\eta_p^2 = .266$	**Lag x Group:** $F_{1.9, 59.6} = .54$, $p = .57$, $\eta_p^2 = .017$ **Lag x Group x Sex:** $F_{1.9, 59.6} = .03$, $p = .96$, $\eta_p^2 = .001$
	500	T1	1.65 (.65)	1.64 (.38)	**Group:** $F_{1, 32} = .02$, $p = .89$, $\eta_p^2 = .001$	**Target Position x Condition:** $F_{1, 32} = 3.46$, **p =.07**, $\eta_p^2 = .097$
		T2	1.76 (.56)	1.65 (.55)	**Sex:** $F_{1, 32} = .91$, $p = .35$, $\eta_p^2 = .027$	**Target Position x Condition x Group:** $F_{1, 32} = .01$, $p = .92$, $\eta_p^2 = .00$ **Target Position x Condition x Group x Sex:** $F_{1, 32} = 1.40$, $p = .25$, $\eta_p^2 = .042$
	700	T1	2.01 (.74)	1.96 (.52)		**Target Position x Lag:** $F_{1.8, 56.3} = 10.2$, **p <.001**, $\eta_p^2 = .243$
		T2	1.94 (1.0)	1.73 (.54)		**Target Position x Lag x Group:** $F_{1.8, 56.3} = .25$, $p = .75$, $\eta_p^2 = .008$ **Target Position x Lag x Group x Sex:** $F_{1.8, 56.3} = .63$, $p = .52$, $\eta_p^2 = .019$
Reaction Time (RT) *Emotional* condition	200	T1	1.76 (.57)	1.73 (.44)		**Condition x Lag:** $F_{1.5, 49.2} = 1.65$, $p = .21$, $\eta_p^2 = .049$
		T2	2.94 (2.70)	2.41 (.82)		**Condition x Lag x Group:** $F_{1.5, 49.2} = .29$, $p = .69$, $\eta_p^2 = .009$ **Condition x Lag x Group x Sex:** $F_{1.5, 49.2} = .44$, $p = .59$, $\eta_p^2 = .014$
	300	T1	1.74 (.84)	1.72 (.51)		**Target Position x Condition x Lag:** $F_{1.7, 54.3} = .23$, $p = .76$, $\eta_p^2 = .007$
		T2	2.40 (1.36)	2.12 (.78)		**Target Position x Condition x Lag x Group:** $F_{1.7, 54.3} = .15$, $p = .82$, $\eta_p^2 = .005$ **Target Position x Condition x Lag x Group x Sex:** $F_{1.7, 54.3} = .31$, $p = .70$, $\eta_p^2 = .010$
	500	T1	1.70 (.58)	1.66 (.42)		
		T2	2.11 (1.26)	1.96 (.91)		
	700	T1	1.89 (.79)	1.74 (.45)		
		T2	1.76 (.77)	1.64 (.46)		

Figure 6.3. Reaction Time (RT) of male meditators and non-meditators in the *Emotional Attentional Blink (EAB)* paradigm at T1 and T2 target position.



Error bars represent +/- 2 standard error of the mean.

6.3.5 *Prepulse Inhibition Performance*

The main effect of Block amplitude was significant [$F_{2, 80}$ = 10.85, p <*.001*, η_p^2 = .213] in both males [$F_{2, 48}$ = 4.09, p = *.023*, η_p^2 = .146] and females [$F_{2, 32}$ = 10.36, p <*.001*, η_p^2 = .393] (Table 6.5). The interaction of Block x Group [$F_{2, 80}$ = .40, p = *.675*, η_p^2 = .010] or Block x Sex [$F_{2, 80}$ = 1.09, p = *.34*, η_p^2 = .027] were not significant.

The main effect of Trial Type was also significant [$F_{2, 80}$ = 3.04, p = *.053*, η_p^2 = .071]. A paired samples *t*-test showed lower *PPI* for PRP-120 compared to PRP-30 trials [t_{43} = 2.24, p = *.031, d = .337*] (Table 6.5). *PPI* differences between *PPI*-120 and PRP-120 [t_{43} = 1.79, p = *.081, d = .269*] or with PRP-30 [t_{43} =-.52, p = *.604, d = -.079*] were not significant. The interaction of Trial Type x Group [$F_{2, 80}$ = .40, p = *.673*, η_p^2 = .010] or Trial Type x Sex [$F_{2, 80}$ = .39, p = *.677*, η_p^2 = .010] were not significant, indicating that meditators and non-meditators did not differ in *PPI* performance.

Table 6.5. ***Prepulse Inhibition (PPI)*** **amplitude and trial types (means and SDs) in meditators and non-meditators.**

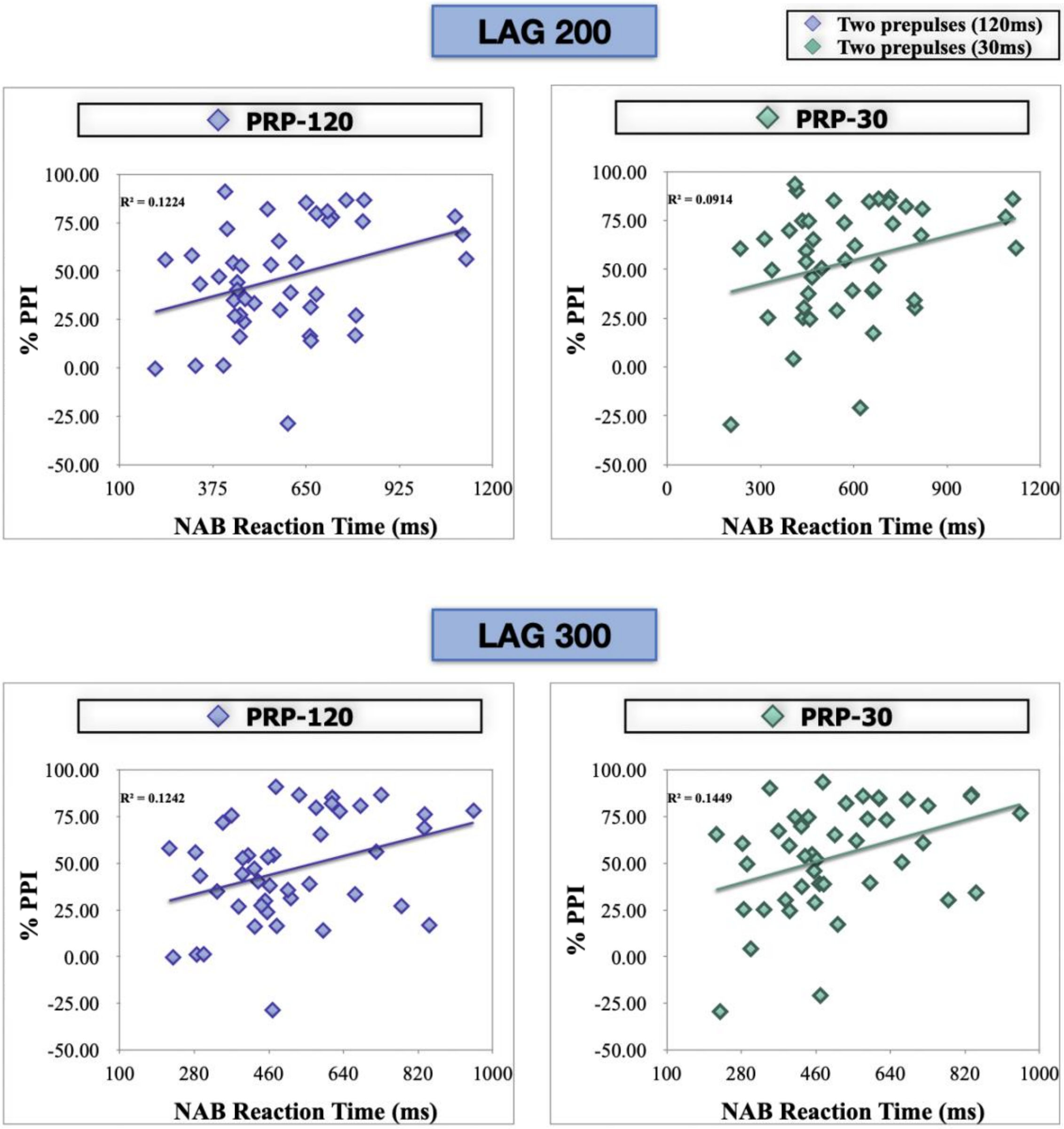
PPI		Meditators (N = 23) Mean (SD)			Non-meditators (N = 21) Mean (SD)			Total (N = 44) Mean (SD)
		Males	Females	Total	Males	Females	Total	
Amplitude	*Block 1*	892.58 (568.28)	590.52 (347.90)	748.12 (490.19)	745.55 (588.36)	1127.48 (885.15)	872.86 (702.92)	807.65 (597.26)
	Block 2	801.67 (618.38)	418.45 (304.77)	618.39 (521.27)	644.88 (482.80)	868.14 (713.43)	719.30 (562)	666.55 (537.14)
	Block 3	759.50 (717.42)	328.58 (285.11)	553.41 (585.44)	536.26 (451.19)	994.10 (916.48)	688.87 (658.19)	618.06 (617.68)
Trial Type	*PPI-120*	43.54 (41.83)	55.10 (24.23)	49.07 (34.30)	57.62 (26.68)	51.16 (26.26)	55.47 (26.07)	52.12 (30.47)
	PRP-30	46.86 (35.32)	55.69 (26.29)	51.08 (30.96)	54.40 (30.51)	62.79 (15.98)	57.19 (26.42)	54 (28.72)
	PRP-120	38.99 (35.96)	52.66 (25.10)	45.53 (31.33)	49.44 (28.30)	44.48 (19.57)	47.78 (25.32)	46.60 (28.32)

6.3.6 *Relationships of PPI with NAB and EAB Paradigm Performance*

No significant associations were found between %*PPI* and either %*NAB* or %*EAB* in the whole sample (Table 6.6). In non-meditators, higher *%PPI* for both *PPI*-120 and PRP-120 was associated with stronger *%EAB* for the *emotional* condition at lag 500 ms and with *%EAB* for the *neutral* condition at lag 700 ms (see Table 6.6).

In the whole sample, higher *%PPI* for both PRP-30 and PRP-120 was associated with slower T2 RTs in the *NAB* paradigm at all lags: 200 ms, 300 ms, 400 ms, 500 ms, and 700 ms (see Figure 6.4 and Table 6.7 for the correlation coefficients and *p* values). For most lags, the same pattern (mainly for T2 stimuli) and direction (positive) of correlations between %*PPI* and *NAB* RT was present in meditator and non-meditator groups (Table 6.7). There were no significant correlations of %*PPI* with *EAB* RT for the *neutral* condition and very few correlations with *EAB* RT for the *emotional* condition, with no consistent pattern either in the whole sample or the meditator/non-meditator groups (see Table 6.7), which are likely to be chance findings due to the total number of performed correlations.

Figure 6.4. Relationships of *Prepulse Inhibition magnitude (%PPI)* for prepulse-to-pulse interval of 30 ms (PRP-30) and prepulse-to-pulse interval of 120 ms (PRP-120) trials with reaction time (RT) at T2 target position for the *Neutral Attentional Blink (NAB)* paradigm.



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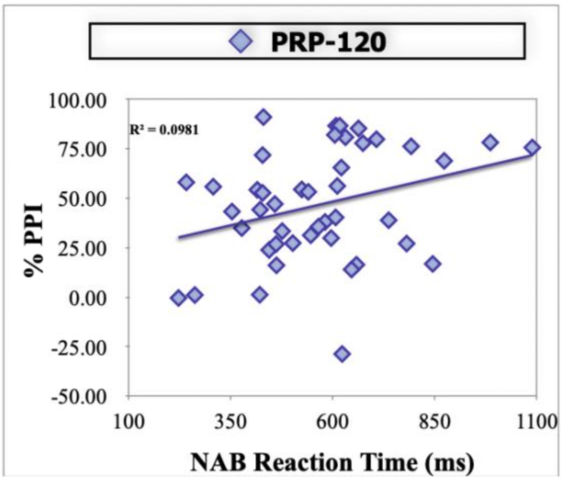
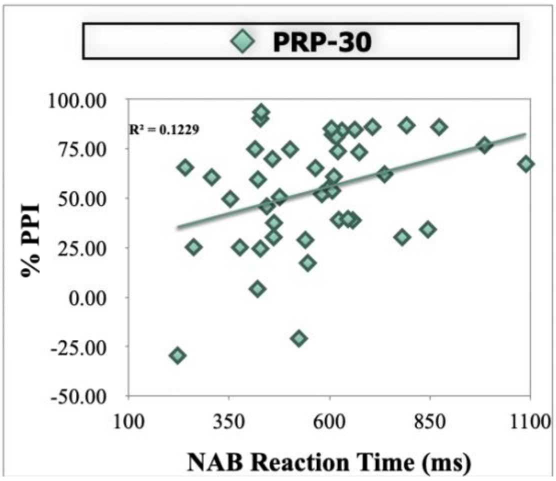
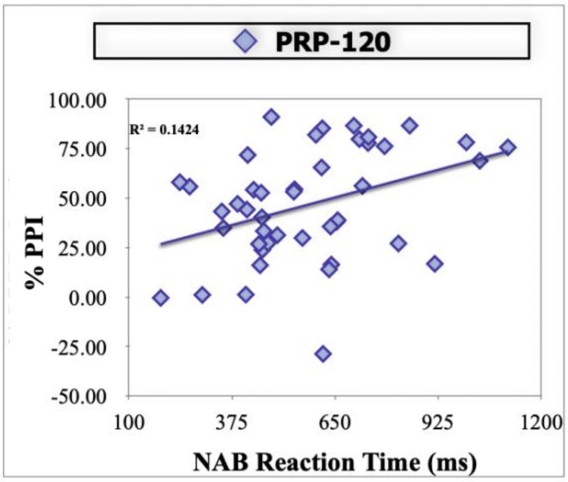
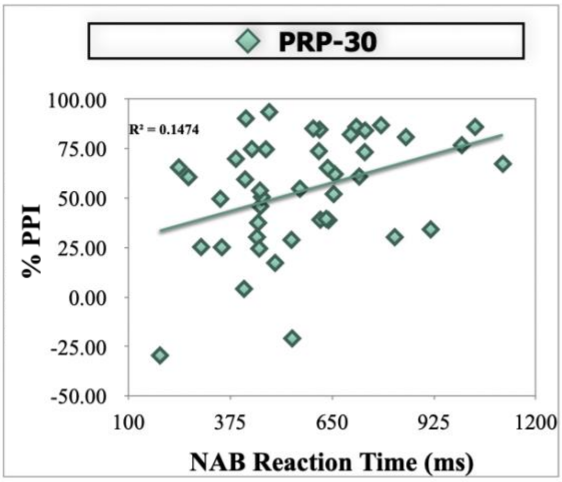


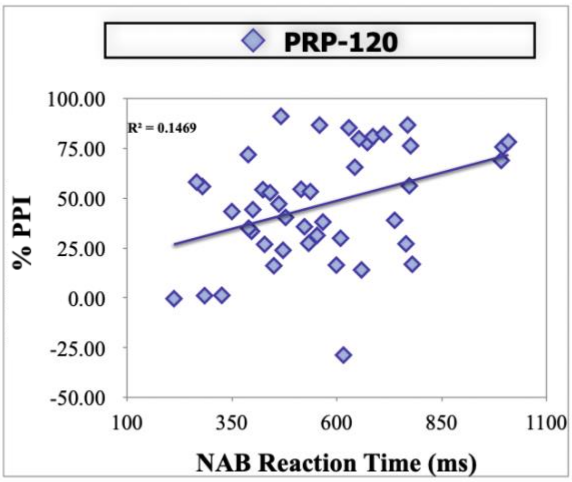


LAG 500





LAG 700



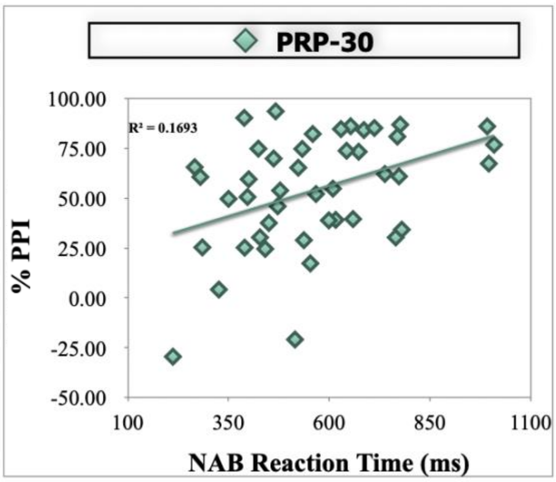


Table 6.6. Relationships of *%PPI* with *NAB* and *EAB* performance (RA).

AB Paradigm (%AB) (RA)	Lag (ms)	Group	Single prepulse (*PPI*-120ms)	Two prepulses (PRP-120ms)	Two prepulses (PRP-30ms)
%NAB	200	Whole sample	.01 *(.93)*	.17 *(.26)*	.12 *(.43)*
		Non-meditators	.07 *(.77)*	.33 *(.14)*	.17 *(.46)*
		Meditators	.00 *(.99)*	.04 *(.86)*	.07 *(.73)*
	300	Whole sample	-.08 *(.61)*	.13 *(.42)*	.03 *(.85)*
		Non-meditators	-.18 *(.44)*	.09 *(.70)*	-.06 *(.80)*
		Meditators	.05 *(.80)*	.16 *(.45)*	.10 *(.65)*
	400	Whole sample	-.20 *(.19)*	-.03 *(.83)*	-.08 *(.63)*
		Non-meditators	-.16 *(.49)*	-.02 *(.94)*	.01 *(.97)*
		Meditators	-.20 *(.37)*	-.02 *(.91)*	-.11 *(.63)*
	500	Whole sample	-.07 *(.66)*	.08 *(.59)*	.07 *(.66)*
		Non-meditators	.04 *(.86)*	.20 *(.38)*	.15 *(.52)*
		Meditators	-.11 *(.61)*	-.02 *(.94)*	.04 *(.84)*
	700	Whole sample	-.08 *(.63)*	.07 *(.67)*	-.03 *(.85)*
		Non-meditators	.14 *(.54)*	.27 *(.24)*	.02 *(.94)*
		Meditators	-.23 *(.29)*	-.10 *(.64)*	-.06 *(.79)*
%EAB Neutral	200	Whole sample	.06 *(.70)*	.06 *(.73)*	.01 *(.96)*
		Non-meditators	.06 *(.79)*	.10 *(.68)*	-.10 *(.67)*
		Meditators	-.12 *(.59)*	.07 *(.73)*	.03 *(.90)*
	300	Whole sample	.13 *(.42)*	.19 *(.21)*	.12 *(.42)*
		Non-meditators	.27 *(.23)*	.30 *(.19)*	.00 *(1.00)*
		Meditators	.00 *(.99)*	.15 *(.51)*	.23 *(.30)*
	500	Whole sample	.10 *(.51)*	.16 *(.30)*	.04 *(.82)*
		Non-meditators	.25 *(.28)*	.23 *(.32)*	-.01 *(.96)*
		Meditators	.02 *(.93)*	.12 *(.59)*	.15 *(.49)*
	700	Whole sample	.25 *(.11)*	.35 *(.02)*	.25 *(.10)*
		Non-meditators	.57 ***(.01)****	.57 ***(.01)****	.38 *(.09)*
		Meditators	.01 *(.97)*	.21 *(.33)*	.23 *(.29)*
%EAB Emotional	200	Whole sample	.11 *(.50)*	.11 *(.48)*	.04 *(.80)*
		Non-meditators	.16 *(.49)*	.19 *(.42)*	-.01 *(.96)*
		Meditators	.05 *(.81)*	.07 *(.75)*	.12 *(.59)*
	300	Whole sample	.11 *(.48)*	.16 *(.30)*	.18 *(.25)*
		Non-meditators	.14 *(.56)*	.17 *(.45)*	.02 *(.94)*
		Meditators	.09 *(.69)*	.21 *(.33)*	.35 *(.10)*
	500	Whole sample	.10 *(.53)*	.15 *(.33)*	.07 *(.64)*
		Non-meditators	.51 ***(.02)****	.50 ***(.02)****	.21 *(.35)*
		Meditators	-.25 *(.25)*	-.03 *(.90)*	-.04 *(.86)*
	700	Whole sample	-.10 *(.50)*	.01 *(.93)*	-.10 *(.53)*
		Non-meditators	.14 *(.54)*	.22 *(.34)*	-.05 *(.82)*
		Meditators	-.31 *(.15)*	-.18 *(.41)*	-.11 *(.62)*

Notes: * Correlation is significant at the .05 level ($p < .05$); ** Correlation is significant at the .01 level ($p < .01$). The *alpha* level for correlations as per hypothesis-testing was maintained at .05 ($p < .05$). The *alpha* level for the correlations that were exploratory/not predicted was set at .01 ($p <. 01$) to adjust for multiple tests.

Table 6.7. Relationships of *%PPI* with *NAB* and *EAB* performance (RT).

				% PPI, r (p)		
***AB* Paradigm (RT)**	**Lag (ms)**	**Group**	**Target Position**	**Single prepulse (*PPI*-120ms)**	**Two prepulses (PRP-120ms)**	**Two prepulses (PRP-30ms)**
NAB	200	Whole sample	T1	.08 (.63)	.13 (.39)	.06 (.71)
			T2	.23 (.14)	.35 (.02)*	.30 (.05)*
		Non-meditators	T1	-.01 (.95)	.28 (.22)	.00 (.99)
			T2	.21 (.37)	.48 (.03)*	.13 (.58)
		Meditators	T1	.15 (.49)	.06 (.79)	.14 (.53)
			T2	.23 (.28)	.26 (.23)	.41 (.05)
	300	Whole sample	T1	.21 (.17)	.28 (.07)	.17 (.28)
			T2	.22 (.16)	.35 (.02)*	.38 (.01)*
		Non-meditators	T1	.27 (.24)	.46 (.03)*	.21 (.36)
			T2	-.01 (.96)	.22 (.34)	.10 (.66)
		Meditators	T1	.21 (.33)	.16 (.45)	.23 (.30)
			T2	.39 (.06)	.47 (.02)*	.63 (.00)**
	400	Whole sample	T1	.11 (.49)	.20 (.19)	.11 (.49)
			T2	.27 (.07)	.31 (.04)*	.35 (.02)*
		Non-meditators	T1	.09 (.68)	.39 (.08)	.09 (.68)
			T2	.15 (.51)	.46 (.04)*	.21 (.37)
		Meditators	T1	.18 (.42)	.14 (.53)	.22 (.30)
			T2	.38 (.07)	.18 (.40)	.50 (.02)*
	500	Whole sample	T1	.15 (.33)	.20 (.20)	.13 (.40)
			T2	.25 (.11)	.38 (.01)*	.38 (.01)*
		Non-meditators	T1	.13 (.58)	.39 (.08)	.11 (.64)
			T2	.13 (.57)	.46 (.04)*	.17 (.46)
		Meditators	T1	.18 (.41)	.13 (.55)	.24 (.27)
			T2	.33 (.13)	.32 (.14)	.57 (.00)**
	700	Whole sample	T1	.21 (.18)	.29 (.06)	.17 (.28)
			T2	.28 (.07)	.38 (.01)*	.41 (.006)**
		Non-meditators	T1	.17 (.46)	.42 (.06)	.09 (.71)
			T2	.15 (.50)	.43 (.05)*	.20 (.38)
		Meditators	T1	.24 (.28)	.18 (.40)	.23 (.28)
			T2	.37 (.08)	.35 (.10)	.58 (.00)**
***EAB* Neutral**	200	Whole sample	T1	.03 (.86)	.17 (.26)	.04 (.81)
			T2	.12 (.46)	.00 (.99)	.12 (.45)
		Non-meditators	T1	.16 (.48)	.28 (.21)	.11 (.64)
			T2	-.09 (.69)	.00 (.99)	.07 (.76)
		Meditators	T1	.01 (.96)	.11 (.63)	.01 (.96)
			T2	.32 (.16)	.05 (.82)	.19 (.42)
	300	Whole sample	T1	.25 (.10)	.21 (.18)	.09 (.55)
			T2	.04 (.79)	.13 (.43)	-.06 (.71)
		Non-meditators	T1	.18 (.43)	.33 (.15)	.11 (.64)
			T2	-.06 (.80)	.11 (.65)	-.10 (.69)
		Meditators	T1	.24 (.27)	.04 (.85)	.06 (.77)
			T2	.17 (.47)	.09 (.70)	.06 (.82)
	500	Whole sample	T1	.19 (.22)	.23 (.13)	.10 (.51)
			T2	.15 (.34)	.24 (.13)	.15 (.34)
		Non-meditators	T1	.17 (.45)	.24 (.31)	.01 (.97)
			T2	.06 (.80)	.18 (.45)	.16 (.47)
		Meditators	T1	.21 (.33)	.18 (.40)	.24 (.27)
			T2	.14 (.56)	.17 (.46)	.04 (.85)

AB Paradigm (RT)	Lag (ms)	Group	Target Position	Single prepulse (*PPI*-120)	Two prepulses (PRP-120ms)	Two prepulses (PRP-30ms)
	700	Whole sample	T1	.22 *(.16)*	.27 *(.08)*	.12 *(.42)*
			T2	.13 *(.40)*	.13 *(.41)*	.03 *(.88)*
		Non-meditators	T1	.33 *(.15)*	.45 ***(.04)****	.20 *(.39)*
			T2	.20 *(.38)*	.21 *(.36)*	.08 *(.73)*
		Meditators	T1	.12 *(.58)*	.05 *(.82)*	.02 *(.92)*
			T2	.06 *(.79)*	.03 *(.91)*	-.03 *(.90)*
EAB **Emotional**	200	Whole sample	T1	.23 *(.13)*	.32 ***(.03)****	.17 *(.28)*
			T2	-.03 *(.85)*	.01 *(.93)*	-.16 *(.31)*
		Non-meditators	T1	.28 *(.23)*	.43 *(.05)*	.14 *(.54)*
			T2	-.10 *(.66)*	.12 *(.60)*	-.28 *(.22)*
		Meditators	T1	.27 *(.21)*	.24 *(.27)*	.19 *(.39)*
			T2	.05 *(.82)*	-.09 *(.69)*	-.05 *(.81)*
	300	Whole sample	T1	.19 *(.22)*	.26 *(.09)*	.09 *(.58)*
			T2	-.18 *(.26)*	-.003 *(.99)*	.03 *(.85)*
		Non-meditators	T1	.16 *(.48)*	.32 *(.16)*	.00 *(.99)*
			T2	-.13 *(.59)*	.05 *(.85)*	-.09 *(.71)*
		Meditators	T1	.33 *(.13)*	.24 *(.27)*	.18 *(.40)*
			T2	-.16 *(.47)*	-.02 *(.93)*	.19 *(.40)*
	500	Whole sample	T1	.13 *(.42)*	.21 *(.17)*	.05 *(.76)*
			T2	.07 *(.68)*	.004 *(.98)*	-.10 *(.56)*
		Non-meditators	T1	.10 *(.67)*	.20 *(.38)*	-.03 *(.90)*
			T2	.06 *(.82)*	.21 *(.37)*	.03 *(.89)*
		Meditators	T1	.17 *(.45)*	.18 *(.42)*	.09 *(.68)*
			T2	.08 *(.72)*	-.17 *(.46)*	-.18 *(.44)*
	700	Whole sample	T1	.01 *(.93)*	.10 *(.53)*	-.06 *(.69)*
			T2	-.03 *(.83)*	.14 *(.38)*	-.004 *(.98)*
		Non-meditators	T1	.02 *(.92)*	.16 *(.49)*	-.14 *(.56)*
			T2	-.02 *(.93)*	.26*(.26)*	-.02 *(.92)*
		Meditators	T1	.04 *(.85)*	.05 *(.82)*	.02 *(.94)*
			T2	-.04 *(.87)*	-.02 *(.94)*	-.04 *(.85)*

Notes: * Correlation is significant at the .05 level ($p < .05$); ** Correlation is significant at the .01 level ($p < .01$). The *alpha* level for correlations as per hypothesis-testing was maintained at .05 ($p < .05$). The *alpha* level for the correlations that were exploratory/not predicted was set at .01 ($p <. 01$) to adjust for multiple tests. Partial correlations for lag 200 (PRP-120: ***p = .03****, PRP-30: ***p = .04****); lag 300 (PRP-120: *p = .14*, PRP-30: ***p = .03****); lag 400 (PRP-120: *p = .21*, PRP-30: ***p = .02****); lag 500 (PRP-120: ***p = .04****, PRP-30: ***p = .01*****); and lag 700 (PRP-120: *p = .08*, PRP-30: ***p = .007*****).

6.3.7 *Relationships of PPI Magnitude with Trait Equanimity and Non-reactivity*

No significant correlations were found of *%PPI* for *PPI*-120, PRP-30 or PRP-120 with trait *equanimity* or *non-reactivity* scores in the whole sample (all *p* values >.11) or in meditators (all *p* values >.28) and non-meditators (all *p* values >.27), separately (see Table 6.8).

Table 6.8. Relationships of *%PPI* with trait *equanimity (NAS-7)* and *non-reactivity (FFMQ)*.

Self-report measures	Group	Single prepulse (*PPI*-120ms)	Two prepulses (PRP-120ms)	Two prepulses (PRP-30ms)
NAS-7 *Equanimity*	Whole sample	-.31 *(.26)*	-.27 *(.33)*	-.43 *(.11)*
	Non-meditators	-.06 *(.91)*	-.06 *(.91)*	-.03 *(.96)*
	Meditators	-.33 *(.38)*	-.20 *(.60)*	-.41 *(.28)*
FFMQ *Non-reactivity*	Whole sample	-.05 *(.74)*	.01 *(.95)*	-.02 *(.90)*
	Non-meditators	-.05 *(.84)*	-.16 *(.48)*	-.25 *(.27)*
	Meditators	-.05 *(.83)*	.14 *(.54)*	.21 *(.33)*

6.4 Discussion

The study examined the differences between meditators and non-meditators in the *AB* (both *NAB* and *EAB*) and *PPI* paradigms' performance with the main aim of investigating the relationships between *NAB/EAB* and *PPI.* The secondary aim was to explore the relationships of *PPI* magnitude with trait *equanimity* and *non-reactivity*. Sex differences in the *AB* and *PPI* paradigms' performance were also explored. Contrary to H1, there were no effects of meditation on *NAB* performance. However, in partial agreement with H2, male meditators identified T2 targets faster than male non-meditators in the *EAB* paradigm. Meditators and non-meditators also did not differ in the *PPI* paradigm performance (H3). In line with H4, higher *PPI* for PRP-30 and PRP-120 (but not *PPI*-120) trials was associated with slower RTs when identifying T2 (but not T1) stimuli correctly in the *NAB* paradigm across all lags (200 ms, 300 ms, 400 ms, 500 ms, and 700 ms). No associations between *PPI* performance with either trait *equanimity* or *non-reactivity* were observed in the whole sample or in the two groups separately (meditators and non-meditators).

6.4.1 *AB Performance*

Both *AB* paradigms (*NAB* and *EAB*) worked as expected, with stronger *NAB* magnitudes (poorer T2 RA) at shorter than longer lags, and stronger *EAB* magnitudes in the *emotional* relative to *neutral* conditions (McHugo et al., 2013). As in Study 1 (Chapter 5), meditators and non-meditators did not differ in the *NAB* or *EAB* paradigm performance. Although the current study had a more homogeneous sample of meditators who were sampled more selectively in terms of practice expertise as compared with the opportunistic sampling used in Study 1, the lack of meditation effects on *NAB* and *EAB* could be due to the relatively small sample of meditators as well as heterogeneity in meditation traditions and/or meditation styles practiced, with the latter possibly diluting meditation effects on *AB* in the meditators group. The small sample of meditators also prevented meditators' categorisation into subgroups of *attentional, constructive or deconstructive* meditation practice families (as introduced by Dahl et al., 2015) and did not allow for the balanced numbers for the MaSD and OMT subgroups. Different meditation styles/practices impact cognitive and/or information processes differentially, as outlined in Chapter 1 (Section 1.1.6) and might have differential effects of meditation on *AB*, as reviewed in Chapter 3 (Section 3.2) (e.g. Braboszcz et al., 2013; May et al., 2011; Sharpe et al., 2021; Slagter et al., 2007; Van Vugt & Slagter, 2014).

Nonetheless, in a partial support of H2, male meditators identified T2 targets comparatively faster than male non-meditators in the *EAB* paradigm overall (i.e. for both neutral and emotional T2 targets). The finding supports beneficial effects of meditation practice on attentional processing efficiency, in line with previous research. Van Leeuwen et al (2012) showed that meditators, relative to non-meditators, were faster in target detection in a global-local paradigm, suggesting that meditation could increase the speed of attentional processing (i.e. how quickly attentional resources are assigned and relocated) without compromising the 'depth' of information processing and, thus, supports more efficient information processing. Other studies have observed enhanced attentional performance with meditation practice (Bailey et al., 2019; Luo et al., 2024; Norris et al., 2018), including improved information processing speed (Eydi-Baygi et al., 2022; Manglani et al., 2020; Prakash et al., 2012). However, a facilitation effect by emotion in female meditators for both T1 and T2 RA when T1 was emotional in the *EAB* paradigm at lag 200 ms observed in Study 1 (Chapter 5) was not replicated in this study.

6.4.2 *PPI Performance*

Contrary to H3, meditators and non-meditators did not differ in the *PPI* paradigm performance, which is in alignment with previous studies (Kumari et al., 2015, 2024). Given that Kumari et al (2024) have observed stronger *PPI* in the subgroup of meditators who self-reported being able to consistently enter and sustain non-dual awareness during formal meditation practice as compared with those who reported not being able to do so, the quality of meditation practice rather than practice hours per se, in addition to the meditation style/approach and/or tradition, might need to be taken into account in future research on the effects of meditation on *PPI*.

In terms of general performance findings, lower *PPI* was observed on PRP-120 as compared with PRP-30 trials, as expected (Kumari et al., 2003). Double *prepulses* with 30-ms intervals trials do not significantly disrupt *PPI* due to a weaker impact on the *pulse* (Kumari et al., 2003).

No sex differences in *PPI* were found in either meditator or non-meditator groups, which is contrary to previous studies that reported lower *PPI* in female non-meditators (Bannbers et al., 2010; Kumari et al., 2003, 2008). The lack of sex differences, particularly in non-meditators group, is most likely due to a very small sample of female non-meditators (n = 7).

6.4.3 *Relationship between AB and PPI Paradigm Performance*

Supporting H4, higher *PPI* magnitude for double (PRP-30 and PRP-120), but not single (PPI-120), *prepulse* trials was associated with slower RTs to correct T2 responses during the *NAB* paradigm performance, which was specific to T2 (not present for T1) stimuli and consistent across all five lags: 200 ms, 300 ms, 400 ms, 500 ms and 700 ms in the whole sample, with a similar pattern of associations in the meditator and non-meditator groups. In non-meditators, higher *%PPI* for both PPI-120 and PRP-120 was associated with stronger *%EAB* in the *emotional* condition for lag 500 ms and in the *neutral* condition for lag 700 ms, suggesting that stronger filtering/ gating possibly does increase the *AB* effect. The lack of significant associations between the magnitudes of *PPI* (%*PPI*) and *NAB* (%*NAB*) at any of the lags suggests that sensorimotor gating, as indexed by *PPI*, does not directly relate to the *AB* effect itself. The observed positive relationship between *PPI* magnitude and RTs for correct T2 stimuli specific to the double-*prepulse* trials could be due to these trials having a greater similarity to the *NAB* paradigm trial design where two targets are separate by at least one distracter (i.e. lag 200 ms) or more. However, the precise nature of this relationship is not clear. Given that the correlations of *%PPI* for PRP-30 and PRP-120 with *%NAB* at the *AB*-inducing lags 200ms and 300ms are very weak, this relationship cannot be interpreted as an association of stronger *PPI* with stronger *NAB*. It rather suggests that stronger sensory gating/filtering as indexed by stronger *PPI* might affect access to attended T2 stimuli within the information processing stream, resulting in slower RTs to correctly identified T2 targets, possibly due to greater uncertainty in one's responses. Future studies might ask the participants to rate the confidence of their T1 and T2 responses to further examine the association of stronger *PPI* with slower RTs to T2 stimuli during the *NAB* paradigm performance.

Cornwell et al (2006) conducted a study in non-meditators where participants completed the *NAB* paradigm (with lags 100 ms, 200 ms and 300 ms) whilst simultaneously being presented with the *PPI* paradigm. At the stage where T1 target position in the *NAB* paradigm was presented, *PPI* magnitude was positively (and primarily) associated with *NAB* magnitude at T2 RA for lag 300 ms, in addition to weaker positive associations with T2 RA for lag 200 ms (i.e. strongest effect was at lag 300 ms). It was suggested by the authors that the positive association between the strength of inhibition (as indexed by *PPI*) and the duration of inhibition (as indexed by *AB*) are related processes within the attentional system. The present study extends the findings of Cornwell's et al (2006) and suggests that RT as an index of *AB* paradigm performance should also be used when examining the relationships between the *PPI* and *AB* paradigms' performance in future research.

It is also important to highlight that the associations with T2 RT were found only for the *NAB* paradigm, with the only positive association of *PPI* magnitude at PRP-120 with RT for correct T1 stimuli in the *emotional* condition of the *EAB* paradigm, which is not reflective of an association with an *AB* effect per se. As anticipated, *NAB* paradigm performance has a stronger relationship with *PPI* paradigm performance than *EAB*, possibly due to both paradigms using semantically neutral stimuli. In addition, *NAB* targets were shorter in length (digits vs words in the *EAB* paradigm) and therefore quicker to process, which makes them more similar to the acoustic prepulse and pulse stimuli of the *PPI* paradigm.

6.4.4 *Relationship of PPI Performance with Trait Equanimity and Non-reactivity*

Unlike the associations of higher trait *equanimity and non-reactivity* with smaller *EAB* in (specifically) mindfulness meditators in Study 1, no relationships between these traits were observed with *PPI*. A possible explanation is that, unlike *EAB*, *PPI* is driven by the mechanisms that do not involve *attentional capture*, which should be diminished by higher *equanimity* and *non-reactivity*. Since *PPI* is thought to be underlined by an automatic mechanism of sensorimotor gating that is outside of conscious control, trait *equanimity* and *non-reactivity* levels might not impact *PPI* performance. Also, although startle stimuli might be argued to present 'threat' and therefore be of emotional valence, there is a rapid habituation to the startling stimuli, which means that a standard *PPI* paradigm is unlikely to maintain the same level of emotional arousal as the *EAB* paradigm where each T2 stimulus was presented once. Future studies might use the fear-potentiated *PPI* paradigm for investigating the associations of *PPI* with trait *non-reactivity* and *equanimity*. They should also investigate whether other meditation-related changes, such as an ability to enter and sustain non-dual awareness are associated with the fear-potentiated *PPI*, given the previous finding of higher *PPI* in meditators who self-reported being able to enter and sustain non-dual awareness (Kumari et al., 2024).

6.4.5 *Strengths, Limitations and Future Directions*

In comparison to Study 1 (Chapter 5), the meditators sample in the current study was much more homogeneous, with 74% of the meditators practicing mindfulness meditation as secularly defined. On the other hand, the small numbers in the OMT meditator subgroup (n = 6) did not allow for investigating *AB* and *PPI* effects and their relationships in two meditator subgroups separately. The meditators in the current study were also older on average (44.21 years of age in Study 2 compared with 33.38 years of age in Study 1) and more experienced (16.03 years of meditation practice in Study 2 compared with 2.42 years of practice in Study 1). However, despite the meditators in the present study being recruited selectively and being more experienced than those recruited for Study 1, no effect of meditation on either *AB* or *PPI* was observed. The small number of female meditators (n=11) in the present study might also be the reason for not being able to replicate the pattern of performance in female meditators on lag 200 ms observed in Study 1. Furthermore, the lack of significant correlations of *PPI* with trait *equanimity* and *non-reactivity* might be due to a smaller sample than in Study 1 (particularly for *equanimity*) rather than the specificity of the association of these traits with *AB*.

Theoretically, there should be no differences in the *AB* paradigm performance between in-lab (as done in Study 2) vs online (as done in Study 1) administration. However, internet speed and connectivity-related issues might potentially affect the *AB* performance online. This was partially dealt with by excluding participants' data with the RTs that were outliers in relation to the sample mean RT, but the measurement error/variation might still have affected Study 1 *AB* performance data. Nevertheless, the meditation effects as interacting with sex on *EAB* performance were observed in Study 1 but not Study 2, suggesting the sample size (statistical power) is more important than the online vs. lab-based *AB* paradigm administration for detecting meditation-related effects on *AB*.

Future studies should investigate the neural correlates of *PPI* and *NAB* to assess whether they have shared neural mechanisms. Studies should also investigate the differential effects of meditation families as per Dahl et al (2015), *attentional*, *constructive* and *deconstructive,* on the relationships between *AB* (both *NAB* and *EAB*) and *PPI* by targeted recruitment of experienced meditators with balanced male and female numbers. Future research should also utilise RT as an index of *AB* paradigm performance, since the findings of the present study highlight its relationship with *PPI* and underlying sensory information processing mechanisms. Meditation practice effects on sensory information processing can be further tested by adopting experimental manipulations of attentional control (e.g. sustained or selective attention) to allow capturing the effect of meditation by comparing a paradigm/condition that involves automatic processing with a paradigm/condition that requires attentional. For example, Kumari et al (2015) observed better performance in meditators as compared with non-meditators on a visuospatial attention task administered simultaneously with the *PPI* paradigm despite no group difference in *PPI*, suggesting stronger attentional capacity in meditators in the presence of similar sensory gating strength relative to non-meditators.

A large number of correlations were performed in the study without correction for multiple tests. The significance of at least some correlations could be due to Type 1 error. However, the significant positive associations between *PPI* magnitude and T2 RT on the *NAB* paradigm had a consistent pattern across the lags in the whole sample and meditator and non-meditator groups. These novel explorative findings will need to be replicated in future studies.

6.4.6 *Conclusion*

In conclusion, although meditation had no significant impact on *PPI* paradigm performance, there were associations between stronger sensory gating and slower correct identification of T2 targets during the *NAB* paradigm performance, the reasons for which are not clear from the present study/paradigm design. No associations of *PPI* with trait *equanimity* and *non-reactivity* were observed; however, male meditators demonstrated more efficient attentional processing during the *EAB* paradigm, indicating greater attentional capacity and/or emotion regulation. Investigating *AB* and *PPI* associations helps to shed light on the effects of meditation on early sensory information processing mechanisms, which can be potentially utilised for enhancing the efficacy of the MBIs in clinical disorders characterised by deficient sensory gating (e.g. schizophrenia, attention-deficit hyperactivity disorder).

Chapter 7 (Study 3): *Affective Priming* in Meditators and Non-Meditators, and its Relationship with *Emotional Attentional Blink* Performance

Chapter Overview

As reviewed in Chapter 3 (Section 3.4), previous studies show improved performance on *Affective Priming (AP)* paradigms (Hutcherson et al., 2008; Liu et al., 2021; Schroter & Jansen, 2022), indicating that reduced *AP* effect in meditators is driven by more efficient emotion regulation. More efficient attentional processing of affective information is also thought to underly attenuated *Emotional Attentional Blink* (*EAB*) in meditators (Makowski et al., 2019; Roca, Vazquez, Diez, & McNally, 2023; Roca & Vazquez, 2020), as reviewed in Chapter 3 (Section 3.2). However, the link between *AP* and *EAB* in meditators and non-meditators has not been previously examined.

Although there were no significant differences either in the *NAB* or *EAB* performance (administered online) between meditators and non-meditators in Study 1 (Chapter 5), it provided evidence of differential (i.e. not observed in male meditators or male and female non-meditators) emotional attentional processing in female meditators at lag 200 ms in the *EAB* paradigm, with higher RA for both T1 and T2 stimuli when T1 stimuli was emotional, suggesting that although there was a facilitation by emotion of T1 stimuli processing and identification this did not affect T2 processing and identification accuracy, that is, did not result in stronger *EAB* at this *AB*-inducing lag. Additionally, smaller *EAB* was significantly associated with higher trait *equanimity* and *non-reactivity* in the whole sample and mindfulness meditators.

Study 2 (Chapter 6) provided evidence of faster attentional processing in male meditators during the *EAB* paradigm (faster RTs to T2 stimuli relative to male non-meditators after both neutral and emotional T1 stimuli in a separate (smaller) sample of meditators who performed the *NAB* and *EAB* paradigms in a lab environment. It also found that slower RTs to correct T2 stimuli in the *NAB* (but not *EAB*) paradigm were associated with higher *PPI*.

This chapter builds upon previous empirical chapters by examining the effect of meditation on *AP* by comparing meditators and non-meditators, since meditation practice is associated with more efficient emotional processing as well as with reduced information cognitive and affective biases during sensory information processing (as discussed in Chapter 1). The study also examines the relationships between *AP* and *AB*, on the focus on *EAB* since both *AP* and *EAB* paradigms involve affective stimuli, to explore whether the two phenomena are underlined by shared mechanisms generally and in meditators specifically.

The current chapter first presents a summary of emotion regulation mechanisms (*equanimity* and *non-reactivity*) associated with meditation more generally and mindfulness meditation specifically, followed by a brief overview of emotional processing as assessed via the *AP* paradigm as well as a brief overview of the interplay between attentional capacity and emotional processing as assessed by the *AB* paradigm. The study assesses *AP* paradigm performance in meditators and non-meditators and the relationships of *AP* with *AB* (both *NAB* and *EAB*, with the focus on *EAB*) as well as with trait *equanimity* and *non-reactivity* in a sample largely overlapping with the Study 1 sample.

Abstract

Affective stimuli, particularly pain-related, are more readily attended to and processed compared with neutral stimuli. The *Affective Priming (AP)* paradigm investigates how valence of subliminal prime stimuli affects subsequent evaluation of the target stimuli, with *incongruent* primes (mismatched valence to that of a target stimulus) leading to an altered (not as expected as per stimulus valence) evaluation of target stimuli, whereas *congruent* primes (matched valence) facilitate the speed and more accurate (as expected as per stimulus valence) responses to target stimuli. No previous studies performed in the context of the effects of meditation on *AP* have used a typical *AP* paradigm to compare mediators and non-meditators. The main novel aims of the present study were therefore to investigate: i) effects of meditation generally and mindfulness meditation specifically on the *AP* paradigm performance, with the meditators expected to be less affected by the primes when responding to the targets compared with non-meditators; ii) the relationships between *AP* and *EAB* paradigm performance generally and in the meditators and non-meditators separately; and iii) the relationships of *AP* magnitude with trait *equanimity* and *non-reactivity* as two possible underlying mechanisms of efficient emotion regulation afforded by meditation practice, the higher levels of which were found to be associated with smaller *EAB* in Study 1 (Chapter 5). The effect of sex in *AP* paradigm performance was also explored. A total of 104 healthy participants (Mean age = 33.80$\pm$9.86; Male/Female = 68/36) who took part in Study 1 were included in the final analysed sample, including 49 meditators (Male/Female = 31/18) and 55 non-meditators (Male/Female = 37/18). Participants completed *AP, NAB* and *EAB* paradigms as well as self-report measures of trait *equanimity*, mindfulness, empathy, and emotion regulation. The *AP* paradigm included 3 primes (happy, sad and neutral facial expressions) presented with two durations within the subliminal range (28ms, 42ms), which were either congruent or incongruent in valence with the three types of pain-related images as target stimuli (physical pain, emotional pain, and non-painful). The *NAB* and *EAB* paradigms were the same as described in Study 1 (Chapter 5). The performance on *NAB* and *EAB* paradigms was indexed by response accuracy (RA), reaction time (RT) and *AB* magnitude (*%NAB/EAB)* and on the *AP* paradigm by %RA and *AP* magnitude *(%AP)*. As predicted, meditators, relative to non-meditators, showed no significant priming effects in either *congruent* or *incongruent* conditions (happy as compared with sad primes showed no %RA differences), with both higher %RA and faster RTs following sad and neutral primes for painful targets, whereas non-meditators displayed strong priming effects for *incongruent* conditions (lower %RA following happy as compared with neutral primes, with

faster RTs to both sad and happy primes for painful targets). Female non-meditators showed the strongest *AP* effect (higher %RA for *congruent*, relative to *incongruent*, conditions) and a stronger prime effect (lower %RA for *incongruent* conditions), relative to female meditators. Significant associations between *AP* and *EAB* were present in meditators and non-meditators, but their pattern was inconsistent, making it difficult to interpret. Smaller *AP* in *incongruent* conditions was significantly associated with higher trait *equanimity* and *non-reactivity* in meditators (mindfulness meditators and other traditions) and the whole sample. Together, findings indicate that meditators were less impacted by prime valence in the *AP* paradigm relative to non-meditators, which was potentially driven by a reduced valence perception of primes (i.e. perceiving affective stimuli as *more neutral*). They also highlight important sex-related differences, with female non-meditators being most impacted by emotional prime valence whereas female meditators did not show this effect. Findings highlight that meditative practices reduce emotional impact from affective stimuli and lead to more efficient processing of affective information.

7.1 Introduction

7.1.1 *The Effect of Meditation on Emotion Regulation*

As outlined in Chapter 1 (Section 1.2), meditation generally and mindfulness meditation in particular enable more efficient emotion regulation with greater control over habitual reactions, affording stronger resilience in the face of negative events and reducing emotional distress, with the main mechanisms being the non-judgemental and non-reactive qualities of mindful awareness towards all experiences, including emotions (Garland et al., 2015; Salgó et al., 2021; Tang et al., 2016) as well as a state of *equanimity* (see Chapter 1, Sections 1.2.5 and 1.2.6). *Non-reactivity* entails the awareness of thoughts, emotions, and body sensations without habitually reacting to or suppressing them, allowing them to 'come and go' with no attachment or avoidance (Iani et al., 2019; Zou et al., 2020) (further details in Chapter 1, Section 1.2.6). This in turn fosters an even engagement (i.e. non-judgemental attention) towards negative, positive or neutral stimuli (Brown et al., 2007; Garland et al., 2015). *Equanimity* is a steady state of *non-reactivity* towards one's own experiences, with further qualities (to those of *non-reactivity*) of tenderness and warmth towards all experiences (Sahdra et al., 2010). *Equanimity* serves as a foundation for self-compassion, which extends to empathy and compassion towards others (Whitehead et al., 2018, 2021). *Non-reactivity* and *equanimity* are assumed to diminish *attentional capture* by emotionally salient stimuli (Chapter 1, Section 1.3.5), with higher trait *equanimity* and *non-reactivity* found to be associated with smaller *EAB* in Study 1 (Chapter 5), which is thought to be driven by *attentional capture* (Chapter 1, Section 1.4.3).

7.1.2 *Affective Priming*

Emotionally valent stimuli, whether positive or negative, are given precedence over neutral ones for further evaluation and processing as they compete for limited attentional resources (Fazio et al., 1986). As discussed in Chapter 1 (Section 1.6.1), *AP* refers to a phenomenon that arises when a valent stimulus (prime) impacts the evaluation of (response to) the upcoming target stimulus, if the two are presented within <300ms of each other (from prime-onset to target-onset). It has been extensively investigated using the *AP* paradigms of various designs (e.g. Fazio et al., 1986; Klauer & Musch, 2003). *AP* effect is typically indexed by a difference in reaction times to, or evaluation accuracy of, the targets when the primes match them on valence (*congruent* condition) vs. when they do not (*incongruent* condition) (e.g. Fazio et al., 1986; Wu et al., 2021). *Congruent* primes therefore lead to faster target evaluations and stronger responses (that is, 'priming' the response to/evaluation of the targets) whereas *incongruent* conditions lead to slower target evaluations, presumably due to the primes triggering an associative network that interferes with the processing of and evaluation of/response to the target (see Chapter 1, Section 1.6.1). Primes presented subliminally (with shorter durations outside of conscious awareness, typically <50ms) produce stronger priming effects (Barbot & Kouider, 2012), with *attentional capture* (Section 1.3.5) by the primes suggestively contributing to and/ or driving their effects (Skalska et al., 2006) (Chapter 2, Section 2.4).

7.1.3 *The Effects of Meditation on Affective Priming*

No previous studies have utilised the *AP* paradigm design as described in Chapter 2 (Section 2.4). The only two studies (Hutcherson et al., 2008; Schroter & Jansen, 2022) that utilised an *AP* principle investigated whether a brief intervention using LKM would have an effect on evaluation of targets, i.e. the LKM was used to prime responses to the tasks. The findings suggested higher accuracy in target identification and faster RTs to targets during performance on the tasks used in the studies (improved musical processing or implicit positive responses) following the LKM. The current study was therefore the first to investigate the effects of meditation on *AP* using a typical *AP* paradigm design, with emotional images as primes (facial expressions) and targets (emotional and physical pain) presented in *congruent* and *incongruent* prime/target conditions.

7.1.4 *The Effects of Sex on Affective Priming*

Females are generally better at perceiving and responding to emotional states during the early stages of automatic affective processing with enhanced perceptual sensitivity to emotional signals (e.g. Gohier et al., 2013). Sex differences in *AP* performance have been reported (Tanaka et al., 2021), with females demonstrating greater *AP* effects compared with males for positive prime faces (Donges et al., 2012) as well as a stronger sensitivity to negative primes which reflects interference processes in females (Gohier et al., 2013). Sex differences in *AP* in meditators have not been previously investigated.

7.1.5 *Attentional Capacity and Emotional Processing: Attentional Blink Paradigms*

As introduced in Chapter 1 (Section 1.4), *Attentional Blink* (*AB*) paradigms such as the *NAB* and *EAB* measure the distribution of attentional capacity and emotional processing, respectively. In summary, the *NAB* quantifies attentional capacity in a neutral context where the first stimulus ('T1') and the second stimulus ('T2') are neutral targets presented within a time period of 200 ms – 500 ms. The *EAB* quantifies attentional capacity in an emotional context with the emotional saliency of 'T1' impairing the detection of a subsequent neutral 'T2' stimulus (Arnell et al., 2004). In summary, the effects of meditation show an overall attenuation of *NAB* (Fabio et al., 2018; Slagter et al., 2007; van Leeuwen et al., 2009; Van Vugt & Slagter, 2014; Wang et al., 2021) and *EAB* (Makowski et al., 2019; Roca, Vazquez, Diez, & McNally, 2023; Roca & Vazquez, 2020) effects. *EAB* findings in Study 1 and 2 (Chapters 5 and 6) highlighted some sex-and group differences, with Study 1 showing differential *EAB* emotional attentional processing for female and male meditators due to reduced *attentional capture*, in contrast with Study 2 where male meditators showed faster *EAB* processing compared with male non-meditators. Due to its emotional component, it is probable that *AP* performance is associated with *EAB* performance, though, this has not been investigated before.

7.1.6 *Summary and Methodological Adaptation (Song et al 2019)*

The current study used an adapted version of the *AP* paradigm utilised in Song et al (2019). The authors used face images depicting sad, fearful, and neutral eye regions and as primes presented subliminally (for 16-ms duration) before the target images that depicted either physically painful (i.e. fingers being cut) or non-painful (i.e. no cut) scenes (Song et al., 2019). The *AP* paradigm used in the present study was modified in a number of ways: (i) two prime durations (28 ms and 42 ms) were included to explore the effects of subliminal vs (more) supraliminal (conscious) presentation of prime stimuli to assess which prime duration might be better at distinguishing meditators and meditators on the *AP* paradigm performance; and (ii) *emotional* pain type was assessed in addition to *physical* pain; for the emotional pain target image, the eye region was emphasised since eye cues are key in the detection and expression of sadness and takes priority in face processing (Song et al., 2019); (iii) instead of using sad, fearful, and neutral primes, as used by Song et al (2019), sad, happy, and neutral primes were used to examine the priming effects of both negative and positive affect on the evaluation of emotional and physical pain stimuli in meditators and non-meditators. The overall structure of the *AP* paradigm trials was the same as used by Song et al (2019) (further methodological details are presented in Section 7.3.2). The painful targets utilised in the paradigm could evoke empathy for pain; since observation of others' pain is a highly salient stimulus (Cui et al., 2017) and possibly impact *AP* performance, e.g. those with higher empathy could be possibly more impacted by negative primes.

7.1.7 *Aims and Hypotheses*

The main and novel aims of this study were to examine: i) the effects of meditation generally and mindfulness meditation in particular; ii) the relationships between *AP* and *AB*, with the focus on *EAB*, as both phenomena engage affective processing, tapping into emotion regulation; and iii) the relationships of *AP* with trait *equanimity* and *non-reactivity.* Given that female non-meditators consistently showed stronger *AP* than male non-meditators in previous research, the study explored whether meditation practice abolishes such sex difference in the *AP* paradigm performance.

The study tested the following hypotheses and predictions:

(H1) Meditators will not be affected by the prime *congruence*/*incongruence* on their responses to the targets.

(H2) Non-meditators will be slower and less accurate when responding to the painful targets in *incongruent* compared with *congruent* conditions.

(H3) Female non-meditators, compared to males, will be impacted differently by prime valence, since females demonstrate reduced priming effects for emotionally negative information (Gohier et al., 2013) and higher perceptivity towards happy facial expressions in *AP* paradigms (Donges et al., 2012), relative to males; whilst there will be no effect of sex on the *AP* performance in meditators.

(H4) Stronger *AP* (i.e. higher *AP* magnitude, poorer performance) will be associated with stronger *EAB* (i.e. higher *EAB* magnitude, poorer performance) at lags 200ms and/ or 300ms.

(H5) Weaker *AP* (i.e. lower *AP* magnitude, better performance) will be associated with higher trait *equanimity* and *non-reac1tivity.* Since individuals with higher *equanimity* show a *balanced* state in response to affective stimuli (Wongpakaran et al., 2021), irrespective of their underlying valence (i.e. positive, negative, or neutral; Desbordes et al., 2015), it is plausible that they might also be not as impacted by the prime valence.

7.2 Methods

7.2.1 *Participants*

The subsample of participants constituting the sample of Study 1 completed the *AP* paradigm (in addition to the *NAB* and *EAB* paradigms) as a part of a larger online study. Seven participants with non-compliance with task instructions or missing data were excluded from *AP* paradigm data analysis.

The final analysed sample for the *AP* paradigm consisted of a subsample of 104 participants (Mean age = 33.80; SD = 9.86; age range = 18-65), including 49 meditators (Male/Female: 31/18) and 55 non-meditators (Male/Female: 37/18), out of 129 participants who constituted the final analysed sample of Study 1. The inclusion/exclusion criteria and recruitment procedures were the same as outlined in Study 1 (Chapter 5, Section 5.3.1). Out of these 104 participants, the *NAB* paradigm data were available for 100 participants (49 meditators, 51 non-meditators) and the *EAB* paradigm data for 103 participants (49 meditators, 54 non-meditators) (3 non-meditators in the *NAB* and 1 non-meditator for the *NAB* and *EAB* paradigms, respectively, had incomplete data or data that fitted the criteria for random responding and were, therefore, excluded as per the exclusion criteria outlined in Study 1, Chapter 5, Section 5.3.5).

As in Study 1, the meditator group was further split into two subgroups based on the main meditation tradition: (i) Mindfulness as Secularly Defined (MaSD) and (ii) Other Meditation Traditions (OMT) using the approach described in detail in Chapter 5, Section 5.3.1).

7.2.2 *Procedure*

All participants were first presented with the participation information. After providing online consent, they completed the self-report measures (including MHQ, NAS-7, IRI, DERS and FFMQ), followed by the *AP*, *NAB*, and *EAB* paradigms.

7.2.3 *Affective Priming Paradigm*

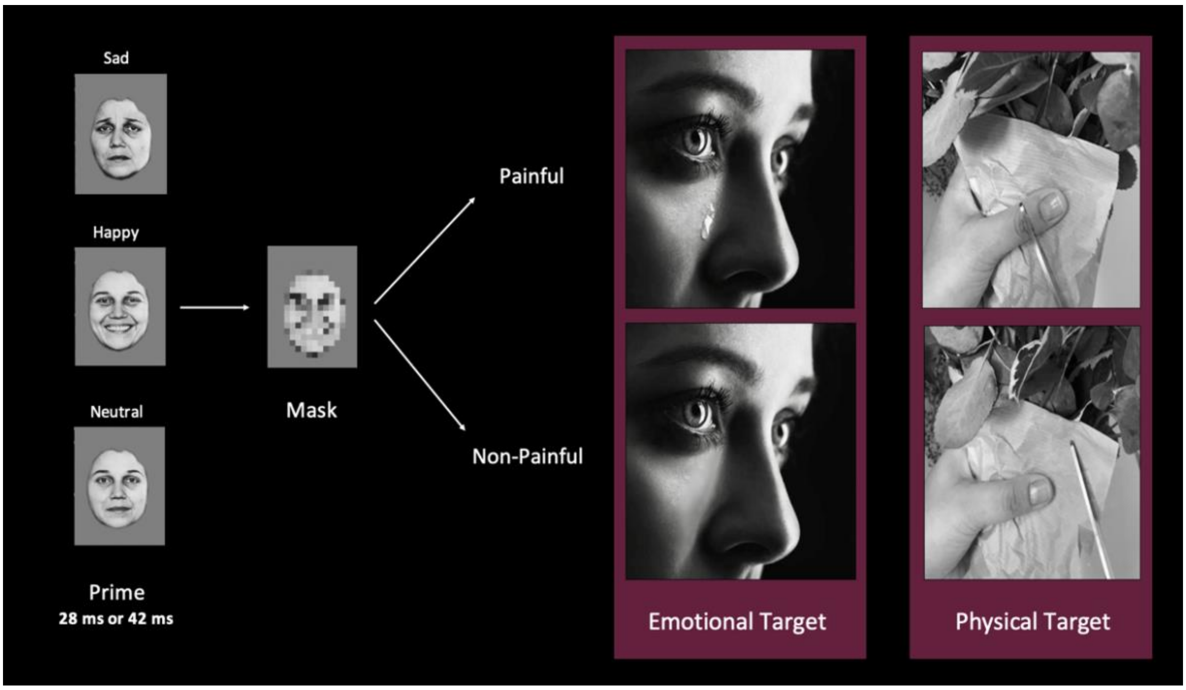
The *AP* paradigm designed for this study was based on the paradigm used by Song et al (2019) (Figure 7.1). It involved primes with sad, happy and neutral faces (Prime Valence: sad, happy, neutral) that were presented for 28 or 42 ms (Prime Duration: 28 ms, 42 ms), followed by a scrambled mask image presented for either 172 ms (following 28-ms primes) or 158 ms (following 42-ms primes) to make a 200-ms interstimulus interval (ISI) before the presentation of the target picture stimuli for 1500 ms, with the target pictures displaying physical or emotional pain (Pain Type: Physical, Emotional) or no physical or emotional pain (Pain Condition: Pain, No Pain). Each trial began with a fixation cross that was presented in the centre of the screen for 500 ms, and followed by a blank screen for 500 ms.

There were 24 different trial types: 3 (Prime Valence) x 2 (Prime Duration) x 2 (Pain Type) x 2 (Pain Condition) (Figure 7.1A), with the total of 192 trials (8 trials per trial type) arranged in four blocks of 48 trials. Different trial types were pseudorandomised (controlling for the mean serial position) within the blocks. The total paradigm duration was approximately 13 minutes.

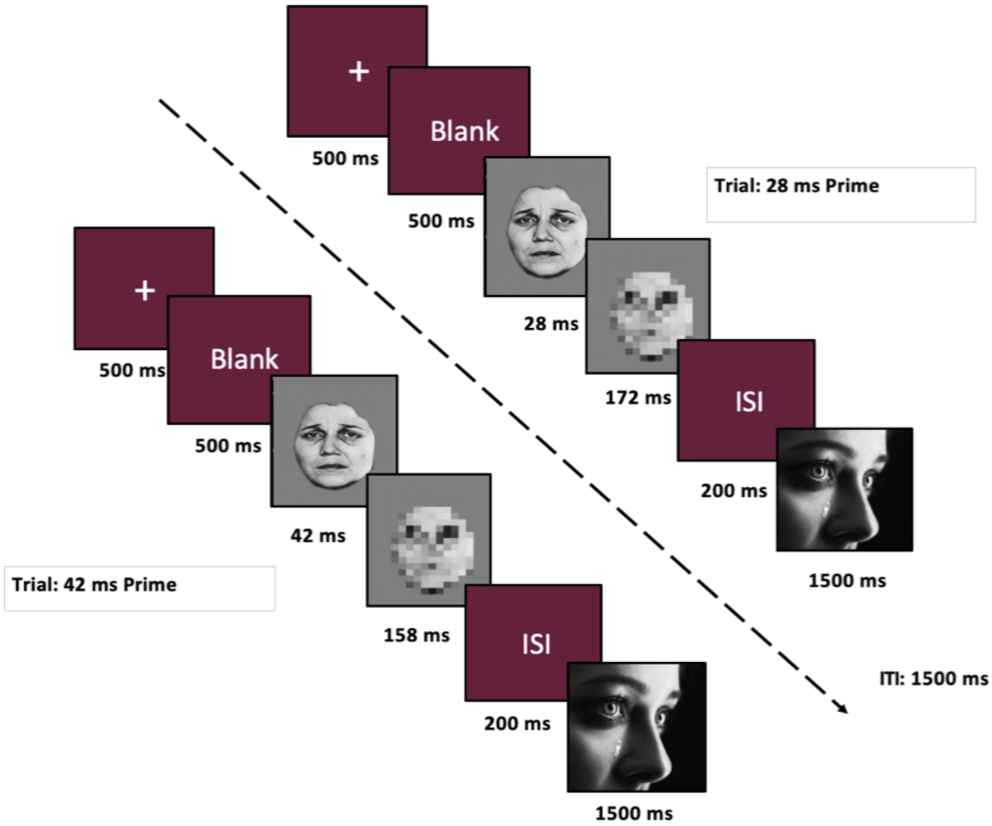
The participants were required to evaluate the presence or absence of pain in the target stimuli, pressing a 'Yes' for the painful and a 'No' button for non-painful target stimuli. The performance was indexed by Response accuracy (RA) and reaction time (RT) to correctly evaluated target stimuli (there were too few commission and omission errors for some of the participants so these indices of performance were not analysed further).

Figure 7.1. The *Affective Priming* Paradigm

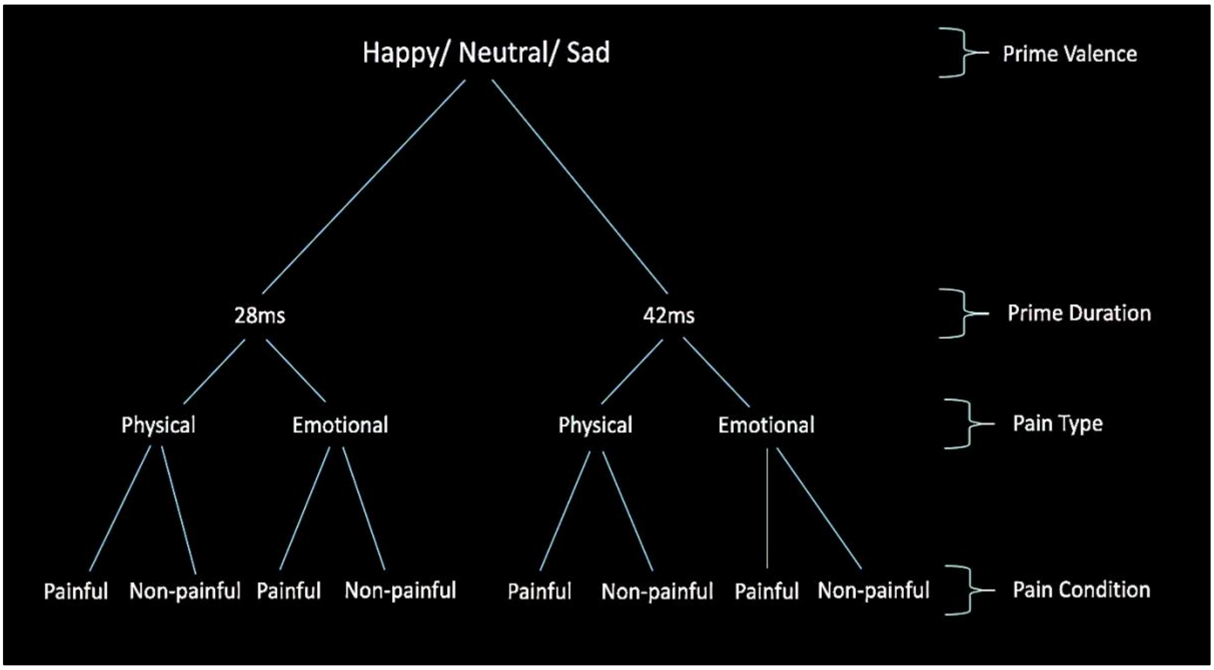
A)



B)



C)



(A) *Affective Priming* (*AP*) paradigm design with face stimuli of three prime valence (sad, happy or neutral), presented for either 28 ms or 42 ms, followed by a scrambled mask image, and then by a photograph showing a painful (either physical or emotional) or a non-painful situation. **(B)** A trial example with the 28-ms or 42-ms primes' duration. **(C)** A diagram of the factors (and their) levels of the *AP* paradigm design with, , prime valence, prime duration, pain type, and pain condition.

7.2.4 *Neutral Attentional Blink and Emotional Attentional Blink Paradigms*

For a detailed description of the *Neutral Attentional Blink* (*NAB*) and *Emotional Attentional Blink* (*EAB*) paradigms, please refer to Chapter 5 (Section 5.3.3). In brief, both paradigms involved a Rapid Serial Visual Presentation (RSVP) of target and distractor stimuli, with the target (T1 and T2) stimuli being embedded in either a stream of distractor letters (*NAB*) or distractor words (*EAB)*. The T1 and T2 target stimuli in the *NAB* paradigm were digits (between 1-9), separated by five inter-stimuli intervals (lags): 200 ms, 300 ms, 400 ms, 500 ms, and 700 ms. The T1 and T2 target stimuli in the *EAB* paradigm were words, separated by four lags: 200 ms, 300 ms, 500 ms, and 700 ms. The *EAB* paradigm had two conditions: *neutral* (neutral T1 target word, neutral T2 target word) and *emotional* (emotional T1 target word, neutral T2 target word).

7.2.5 *Self-Report Measures*

All participants completed self-report measures of trait *mindfulness* and *equanimity*, empathy, and emotional regulation. Meditators also provided detailed information on their meditation history (i.e. practice routine, practice frequency, session duration, types of meditation tradition/style practiced, etc.) by completing the Meditation History Questionnaire (MHQ; presented in Study 1, Chapter 5, Appendix A, Figure A).

7.2.5.1 *Trait Mindfulness, Equanimity, Empathy, and Emotion Regulation*

Trait *mindfulness (non-reactivity)* and *equanimity* were assessed using the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) and Non-Attachment Scale (NAS-7; Sahdra et al., 2016), respectively. A detailed description of each measure is provided in Study 1 (Chapter 5, Section 5.3.4). The FFMQ in the current sample showed a Cronbach's α of 0.83 to 0.85 and the NAS-7 showed a Cronbach's α of .84.

Empathy was assessed using the 28-item Interpersonal Reactivity Index (IRI; Davis, 1980). The IRI assesses four dimensions: *Perspective Taking* (innate attempts to understand others' perspectives), *Fantasy* (the ability to identify with and understand the feelings of fictional characters such as in movies or books), *Empathic Concern* (one's experience of compassionate feelings when another person is experiencing negative or challenging emotions), and *Personal Distress* (experiencing unpleasant emotions when witnessing someone else have a negative experience). Each dimension was assessed by seven statements. The participant rated each of these statements for their relatedness to themselves on a 5-point Likert scale (0 to 4; Davis et al., 1980). Higher scores indicate higher levels of empathy. The IRI subscales are reported to have acceptable to good internal consistency with Cronbach's α ranging from 0.67 to 0.87 (Hawk et al., 2012). In the current sample Cronbach's α for the subscales ranged from 0.67 to 0.73.

Emotion regulation was assessed using the 36-item Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) which measures distinct facets of emotion regulation: ability to control impulsive behaviours, being aware and accepting of one's emotions, and adaptively using emotion regulation techniques to alter emotional responses (Freudenthaler et al., 2017). *DERS-36* has six subscales: [1] *Non-Acceptance of Emotional Responses* (6 items); [2] *Difficulties Engaging in Goal-Directed Behaviour* (5 items); [3] *Impulse Control Difficulties* (6 items); [4] *Lack of Emotional Awareness* (6 items); [5] *Limited Access to Emotion Regulation Strategies* (8 items); and [6] *Lack of Emotional Clarity* (5 items). Each item is rated on a 5-point Likert scale ranging from 1 (*Almost never*) to 5 (*Most of the time*), with a higher sum score indicating greater emotion regulation difficulties. An acceptable-to-excellent internal consistency has been reported for all subscales, with Cronbach's *α* ranging between 0.67 to 0.91 (Salgó et al., 2021). In the current sample Cronbach's *α* for the subscales ranged from 0.85 to 0.91.

7.2.5.2 *Self-Report Data Reliability*

Four attention checks (in the form of repeated items) were included for IRI (item 12), DERS (item 19) and FFMQ (items 7 and 29) to identify potential random responding by assessing response consistency, as detailed in Study 1 (Chapter 5, Section 5.3.4.2).

7.2.6 *Statistical Analysis*

All analyses were performed using IBM SPSS Statistics, version 28.0 (IBM Corp., 2019). Alpha level for testing significance of effects was maintained at $p \leq .05$ unless stated otherwise. All variables of interest were checked for the normality of the distribution prior to applying parametric (or non-parametric as required) analysis approaches.

AP performance was indexed using Response Accuracy (%RA), Reaction Time (RT) to correct responses, and *AP* magnitude (*%AP)*.

%RA was calculated separately for happy, sad and neutral primes to quantify accuracy of target categorisation (pain/no pain) after each presented prime using the following formula:

$$\%RA\ for\ Happy/Sad/Neutral\ prime\ = \left(\frac{Observed\ No.of\ Correct\ RA\ (Happy/Sad/Neutral)}{Maximum\ Possible\ Correct\ RA\ (Happy/Sad/Neutral)}\right) x\ 100$$

%AP was calculated separately for happy and sad primes to quantify the magnitude of priming effect using the following formula (higher *%AP* denotes a stronger *AP* effect):

$$\%AP\ for\ Happy/Sad\ prime\ = \left(\frac{Neutral\ RA - Happy/Sad\ RA}{Neutral\ RA}\right) x\ 100$$

For the analysis involving the *NAB* and *EAB* paradigms, *NAB* and *EAB* magnitude *(%NAB* and *%EAB*) for each lag were used (see Chapter 5, Section 5.3.5 for the formula), with higher *%AB* indexing a stronger *AB* effect.

7.2.6.1 *Sample Characteristics*

Possible group- and sex-related differences in age and self-report measures (FFMQ, NAS-7, IRI, and DERS, total and subscale where relevant) scores were examined using 2 (Group: Meditators, Non-meditators) x 2 (Sex: Male, Female) analysis of variance (ANOVAs), followed by lower order ANOVAs and/or post-hoc mean comparisons as appropriate. MaSD and OMT meditator sub-groups were compared on mean age, the total years and hours of meditation practice, and the self-report measures' scores using independent sample *t*-tests. The relationships between the total hours and the self-report measures' scores were explored using Pearson's correlations across the entire meditator sample.

7.2.6.2 *AP Paradigm*

To test H1-H3, %RA and RT data on the *AP* paradigm were analysed using a 3 (Prime Valence: Happy, Neutral, Sad) x 2 (Prime Duration: 28 ms, 42 ms) x 2 (Pain Type: Physical, Emotional) x 2 (Pain Condition: Painful target stimuli, Non-painful target stimuli) x 2 (Group: Meditator, Non-meditator) x 2 (Sex: Male, Female) repeated-measures Analysis of Co-variance (rmANCOVA) with Prime Valence, Prime Duration, Pain Type and Pain Condition as within-subject factors, Group and Sex as between-subject factors, and age as a co-variate due to a significant mean age difference between Meditator and Non-meditator groups (see Results, Section 7.4). The significant main effects and interactions were followed up using lower order rmANCOVAs, as well as planned (as per hypotheses) and post-hoc (exploratory) between- and/or within-subject pair-wise comparisons, as appropriate. All interactions involving Group or Sex were further evaluated with the FFMQ and DERSs scores added as additional co-variates (given Group x Sex effects in FFMQ and DERS scores, see Results, Section 7.4.1). The Greenhouse-Geisser correction was applied to all interactions involving within-subject factors. The effect sizes, where reported, were partial eta squared (ηp^2; the proportion of variance associated with a factor). The *alpha* level for the planned lower-level rmANOVAs and pair-wise comparisons to further investigate significant interactions as per H1-H3 testing (i.e. interactions involving Group or Sex) was maintained at .05 (p <.05) to avoid committing Type II error. The *alpha* level for the post-hoc analyses of the interactions that were exploratory/not predicted was set at .01 (p <. 01) to adjust for multiple tests to minimise committing Type I error.

7.2.6.3 *Relationships of AP with EAB Magnitude and with Trait Equanimity and Non-reactivity*

To test H4-H5, correlational analyses were conducted between *%AP* and *%NAB/%EAB* using Spearmann's *rho* correlation coefficients (*%AP, %NAB,* and *%EAB* data were not normally distributed) in the whole sample, meditator and non-meditator groups, and meditation subgroups (MaSD, OMT). Spearmann's *rho* correlation coefficients were also used to investigate the relationships of *%AP* with NAS-7 (*equanimity*) and FFMQ (*non-reactivity)* scores. Additionally, Spearmann's *rho* correlation coefficients between *AP* RT and NAS-7 (*equanimity*) were also investigated and are presented in the Supplementary Materials (Appendix C, Table C1). The *alpha* level for the correlations as per H4/H5-testing was maintained at .05 (p < .05) to avoid committing Type II error.

7.3 Results

7.3.1 *Sample Characteristics*

7.3.1.1 *Meditator vs Non-meditator Groups*

The Meditator and Non-meditator groups did not differ in mean age, but there was a significant main effect of Sex [$F_{1, 100} = 7.24$, $p = .008$, $\eta_p^2 = .068$] with females being older than males (Table 7.1). There was no Group x Sex interaction.

For FFMQ *total* (without *Observing*) score, there was a main effect of Group [$F_{1, 100} = 5.06$, $p = .027$, $\eta_p^2 = .048$] with higher scores in meditators relative to non-meditators (Table 7.1). There was also a significant Group x Sex interaction [$F_{1, 100} = 5.07$, $p = .027$, $\eta_p^2 = .048$] that was explained by lower FFMQ *total* scores in female non-meditators than female meditators [$t_{34} = 2.97$, $p = .005$, $d = .989$] and male non-meditators [$t_{53} = 2.68$, $p = .01$, $d = .771$] (no significant differences between male and female meditators or between male meditators and male non-meditators) (Table 7.1). For FFMQ *Describing*, there was a significant Group x Sex interaction [$F_{1, 100} = 7.46$, $p = .007$, $\eta_p^2 = .069$], explained by a higher score in male non-meditators than female non-meditators [$t_{53} = 2.14$, $p = .037$, $d = .613$]. For FFMQ *Acting with Awareness*, the main effect of Sex was significant [$F_{1, 100} = 4.45$, $p = .037$, $\eta_p^2 = .043$] with higher scores in males than females.

For NAS-7, there were no significant main effects of Group or Sex, or Group x Sex (Table 7.1).

For IRI scores, there were no significant main effects or interactions, except for a significant main effect of Sex in *Personal Distress* [$F_{1, 100} = 7.64$, $p = .007$, $\eta_p^2 = .071$] with females scoring higher than males (Table 7.1).

For DERS *total* scores, there was a significant main effect of Group [$F_{1, 100} = 4.92$, $p = .029$, $\eta_p^2 = .047$] with lower scores in meditators, relative to non-meditators. There was also a significant Group x Sex interaction [$F_{1, 100} = 6.08$, $p = .015$, $\eta_p^2 = .057$], explained by female non-meditators scoring the highest of all groups and significantly higher than male non-meditators [$t_{53} = 3.07$, $p = .002$, $d = .882$] as well as female meditators [$t_{34} = 3.22$, $p = .001$, $d = 1.074$]. There was no difference between male and female meditators. For DERS *Impulse*

Control Difficulties, there was a significant effect of Sex [$F_{1, 100} = 6.13$, $p = .015$, $\eta_p^2 = .058$], with higher scores in females than males (Table 7.1), as well as a significant Group x Sex interaction [$F_{1, 100} = 5.80$, $p = .018$, $\eta_p^2 = .055$] which was explained by female non-meditators scoring higher than male non-meditators [$t_{53} = 3.32$, $p = .002$, $d = .954$]. For DERS *Limited Emotion Regulation Strategies*, there was a significant Group x Sex interaction [$F_{1, 100} = 6.69$, $p = .011$, $\eta_p^2 = .063$], explained by higher scores in female non-meditators than male non-meditators [$t_{53} = 2.83$, $p = .006$, $d = .814$]. For DERS *Lack of Emotional Clarity*, there was a significant Group x Sex interaction [$F_{1, 100} = 6.34$, $p = .013$, $\eta_p^2 = .060$], explained by female non-meditators scoring higher than male non-meditators [$t_{53} = 2.03$, $p = .047$, $d = .583$].

7.3.1.2 *MaSD vs OMT vs Non-meditators*

MaSD and OMT groups did not significantly differ in age or on any of the meditation practice indices (Table 7.2).

Both groups had marginally significant differences on IRI subscales, with MaSD group scoring higher than the OMT group on *Perspective Taking* [$t_{47} = 2.02$, $p = .05$, $d = .599$] and lower than the OMT group on *Fantasy* [$t_{47} = 2.12$, $p = .04$, $d = .627$] (Table 7.2). MaSD group scored significantly lower than the OMT group on DERS *Impulse Control Difficulties* [$t_{47} = 3.23$, $p = .002$, $d = .958$] and scored higher than the OMT group on FFMQ *Non-judging* [$t_{47} = 2.65$, $p = .01$, $d = .786$]. (Table 7.2). Both subgroups did not differ on DERS *total*, FFMQ *total* or NAS-7 scores (Table 7.2).

7.3.2 *Meditation Practice Indices*

Meditation experience was quantified using three meditation practice indices: (i) Total Years of Regular Practice (YoP), (ii) Total Hours of Regular Practice (HoP, with and without meditation retreats), and (iii) Intensity of Regular Practice (IoP), using the same approach as detailed Study 1 (Chapter 5, Section 5.4.1.3).

On average, meditators had a total estimated YoP of 3.45 years (SD = 3.23, range = 0.5-15) and a total estimated HoP (with retreat) of 631.86 hours (SD = 1502.43, range = 17.33 – 10156.67). The total HoP with retreat did not correlate significantly with the FFMQ, NAS-7, IRI, or DERS scores (all p values > .23) (Table 7.2).

Table 7.1. Demographic characteristics and self-reported empathy, emotion regulation difficulties, trait *mindfulness* and *equanimity* for Meditator and Non-meditator groups.

Demographics and Self-Report Measures	**Meditators (N = 49)**		**Non-meditators (N = 55)**		**Group Difference**
	Males (N = 31)	**Females (N = 18)**	**Males (N = 37)**	**Females (N = 18)**	**(N = 104)**
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	$F_{1,100}$ (*p*-value)
Age	31.45 (8.59)	37.78 (9.40)	32.38 (9.06)	36.78 (12.50)	.23 (.63)
Interpersonal Reactivity Index					
Perspective Taking	19.16 (4.28)	16.11 (5.54)	17.03 (4.47)	17.50 (5.64)	3.12 (.08)
Fantasy	15.87 (4.58)	15.50 (5.89)	14.78 (5.75)	16.39 (7.17)	.70 (.41)
Empathetic Concern	19.13 (4.75)	19.17 (4.06)	18.62 (4.34)	21.11 (3.89)	1.86 (.18)
Personal Distress	9.84 (4.83)	12.00 (5.36)	10.62 (5.17)	14.33 (5.43)	.53 (.47)
Difficulties in Emotion Regulation Scale					
Non-Acceptance of Emotion	13.42 (6.78)	14.17 (4.68)	13.11 (6.05)	17.22 (6.13)	1.79 (.18)
Difficulties in Goal-directed Behaviour	14.19 (5.01)	14.44 (4.40)	14.81 (5.06)	18.89 (4.55)	3.65 (.06)
Impulse Control Difficulties	12.48 (5.05)	12.56 (4.16)	11.59 (4.87)	16.72 (6.31)	5.80 **(.02)**
Lack of Emotional Awareness	14.97 (3.33)	14.67 (5.33)	16.70 (4.44)	16.61 (5.25)	.01 (.91)
Limited Access to Emotion Regulation Strategies	18.55 (8.31)	16.61 (5.71)	16.95 (7.16)	22.89 (7.58)	6.69 **(.01)**
Lack of Emotional Clarity	11.00 (3.97)	9.28 (3.46)	10.22 (4.10)	12.83 (5.22)	6.34 **(.01)**
Total	84.61 (26.33)	81.72 (18.24)	83.38 (24.61)	105.17 (24.92)	6.08 **(.02)**
Five Facet Mindfulness Questionnaire					
Observing	24.71 (6.34)	27.67 (6.65)	24.14 (7.17)	23.78 (6.46)	1.43 (.24)
Describing	25.90 (6.89)	29.33 (6.24)	27.08 (7.76)	22.39 (7.41)	7.46 **(.007)**
Acting with Awareness	28.42 (6.30)	27.89 (5.69)	28.59 (7.26)	23.44 (6.05)	2.94 (.09)
Non-Judging	28.23 (7.70)	27.44 (7.87)	27.43 (7.34)	23.28 (8.01)	1.14 (.29)
Non-Reactivity	22.03 (4.62)	22.00 (5.72)	21.49 (4.72)	19.61 (5.85)	.77 (.38)
Total without Observing	104.58 (18.27)	106.67 (16.84)	104.59 (21.16)	88.72 (19.35)	5.07 **(.03)**
Non-Attachment Scale					
Equanimity	30.94 (5.32)	32.61 (7.26)	30.27 (6.49)	28.00 (8.20)	2.08 (.15)

Table 7.2. Meditation experience indices, demographic characteristics and self-reported empathy, emotion regulation difficulties, trait *mindfulness* and *equanimity* for Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT) meditation subgroups

Measure	MaSD (n = 31)	OMT (n = 18)	Group Difference
	Mean (SD)	Mean (SD)	$t_{(47)}$ (*p*-value)
Age	35.52 (10.30)	30.78 (6.58)	1.75 (.09)
Meditation Experience Index			
Total Years of Regular Practice	3.71 (3.31)	3.00 (3.13)	.74 (.46)
Total Hours of Regular Practice	353.25 (546.90)	338.08 (332.49)	.11 (.92)
Total Hours of Regular Practice with Retreats	709.05 (1848.31)	498.91 (561.52)	.47 (.64)
Intensity of Regular Practice	-999.80 (926.51)*	-755.23 (951.06)*	.88 (.38)
Interpersonal Reactivity Index			
Perspective Taking	19.10 (4.77)	16.22 (4.86)	2.02 **(.05)**
Fantasy	14.61 (4.43)	17.67 (5.57)	2.12 **(.04)**
Empathetic Concern	20.00 (4.54)	17.67 (4.04)	1.80 (.08)
Personal Distress	9.61 (4.79)	12.39 (5.24)	1.89 (.07)
Difficulties in Emotional Regulation Scale			
Non-Acceptance of Emotion	12.97 (5.74)	14.94 (6.52)	1.11 (.28)
Difficulties in Goal-directed Behaviour	13.81 (4.54)	15.11 (5.11)	.93 (.36)
Impulse Control Difficulties	11.00 (4.11)	15.11 (4.60)	3.23 **(.002)**
Lack of Emotional Awareness	14.87 (4.69)	14.83 (3.03)	.03 (.98)
Limited Access to Emotion Regulation Strategies	16.26 (6.88)	20.56 (7.83)	2.00 (.05)
Lack of Emotional Clarity	10.39 (4.25)	10.33 (3.14)	.05 (.96)
Total	79.29 (23.18)	90.89 (22.88)	1.70 (.10)
Five Facet Mindfulness Questionnaire			
Observing	25.42 (6.72)	26.44 (6.36)	.53 (.60)
Describing	27.10 (7.41)	27.28 (5.81)	.09 (.93)
Acting with Awareness	28.06 (5.49)	28.50 (7.02)	.24 (.81)
Non-Judging	30.03 (7.29)	24.33 (7.18)	2.65 **(.01)**
Non-Reactivity	22.35 (5.23)	21.44 (4.66)	.61 (.54)
Total without Observing	107.55 (18.93)	101.56 (14.81)	1.15 (.26)
Non-Attachment Scale *Equanimity*			
Equanimity (non-attachment)	31.90 (5.99)	30.94 (6.38)	.53 (.60)

* 0 is the cut off point for moderate practice as defined by the Intensity of Practice (IoP) criterion and the formula used to calculate it, i.e. the IoP values equal to or below 0 indicate moderate practice (defined as at least 1 hour once a day over the years of practice), the IoP values above 0 indicate intensive practice.

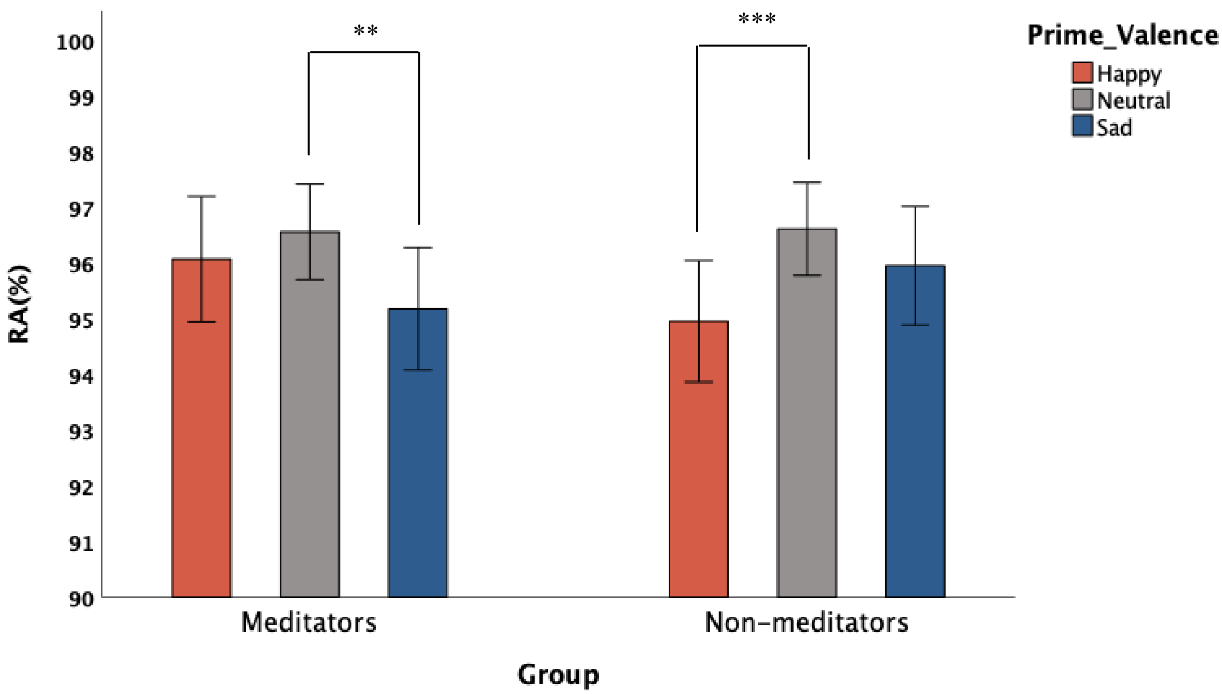
7.3.3 *Affective Priming Paradigm Performance*

7.3.3.1 *Percentage Response Accuracy (%RA)*

For %RA, there was a significant Prime Valence × Prime Duration interaction [$F_{1.98,\ 197.70}$ = 3.65, p = .028, η_p^2 = .036], with higher RA following sad primes of 42-ms duration than following neutral and happy primes (p = .015; no significant difference for happy and neutral primes).

There was a significant Prime Valence x Group interaction [$F_{1.94,\ 192.42}$ = 3.67, p = .028, η_p^2 = .036], with pairwise comparisons showing a higher %RA for neutral primes compared with sad primes in meditators (p = .005), and higher %RA for neutral primes compared with happy primes in non-meditators (p <.001). Meditators had the lowest %RA following the sad primes and non-meditators had the lowest %RA following the happy primes of the three valence types overall (Figure 7.2). This Prime Valence x Group interaction remained significant, albeit becoming somewhat weaker, when covarying for the FFMQ and DERS total scores [$F_{1.94,\ 188.71}$ = 2.84, p = .06, η_p^2 = .028].

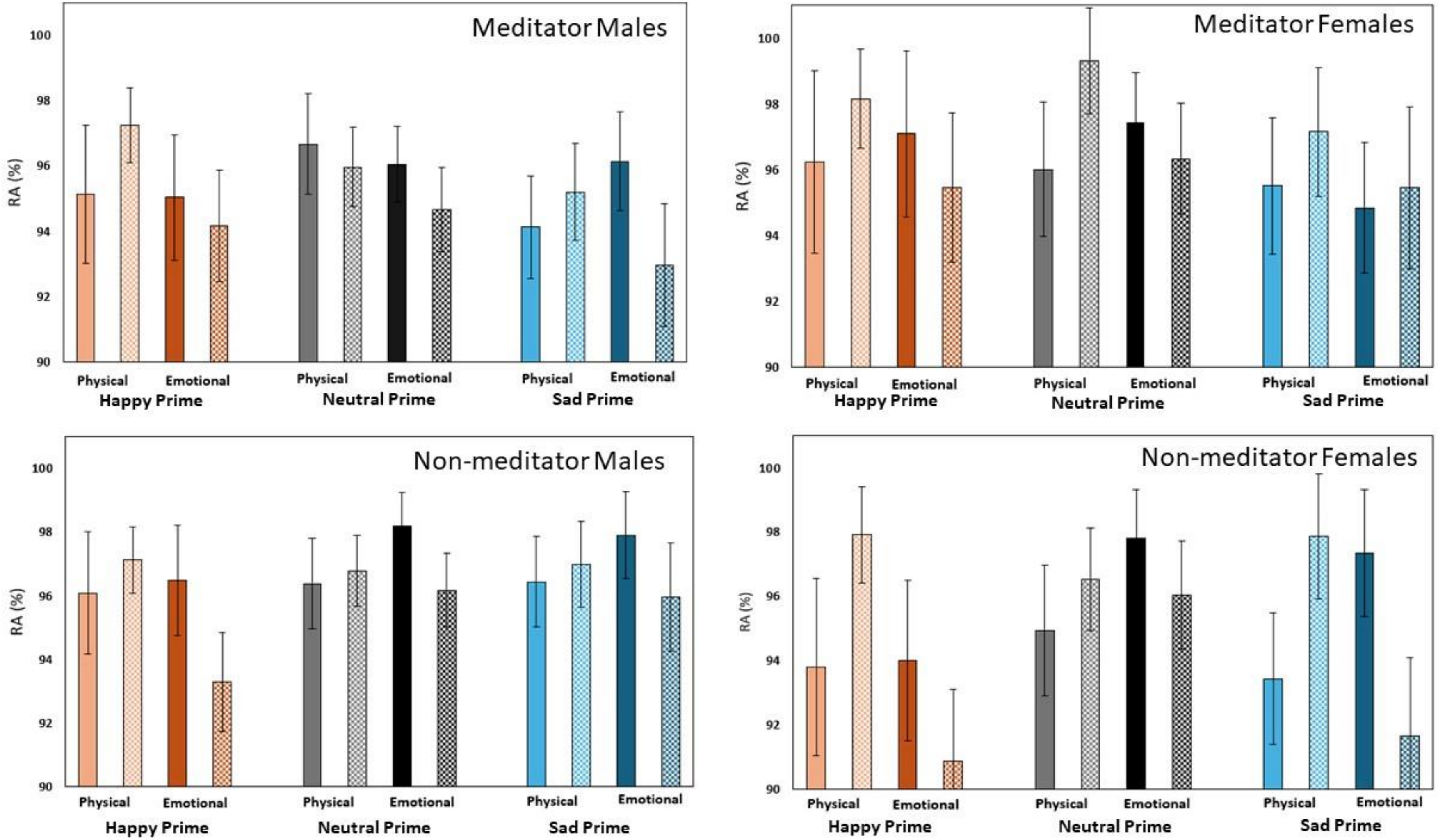
Figure 7.2. Overall Response Accuracy (%RA) in Meditators and Non-meditators in the *Affective Priming (AP)* paradigm following primes of happy, neutral, and sad valence.



Error bars represent +/- 1 standard error of the mean.

There was also a five-way Prime Valence x Pain Type x Pain Condition x Group x Sex interaction [$F_{1.82, 180.56} = 3.19$, $p = .048$, $\eta_p^2 = .031$], which became stronger when covarying for the FFMQ and DERS scores [$F_{1.79, 173.57} = 2.13$, $p = .013$, $\eta_p^2 = .022$]. Lower-order rmANCOVAs (Prime Valence x Pain Type x Pain Condition x Sex), covarying for age, for Meditator and Non-meditator groups separately revealed no significant main effect or interactions (all p >.10). Lower-order rmANCOVAs (Prime Valence x Pain Type x Pain Condition x Group), covarying for age, for females and males separately showed no significant main effects or interactions in males (all p values > .10). In females, there was a trend for the main effect of Prime Valence [$F_{1.95, 64.42} = 2.95$, $p = .06$, $\eta_p^2 = .082$] and for the Prime Valence x Group interaction [$F_{1.95, 64.42} = 2.65$, $p = .08$, $\eta_p^2 = .074$]. Pairwise comparisons to further investigate Prime Valence x Group interaction showed: (i) significantly lower %RA following happy primes in female non-meditators compared with female meditators ($p = .065$); ii) significantly higher %RA following neutral relative to happy primes ($p = .003$) and a trend for higher RA following neutral relative to sad primes in female non-meditators ($p = .059$); and iii) significantly higher %RA following neutral relative to sad primes in female meditators ($p = .018$). Lastly, lower-order rmANCOVAs (Prime Valence x Pain Type x Pain Condition), covarying for age, performed separately for male and female meditators/non-meditators revealed no significant main effect or interactions in male meditators ($p > .97$) or male non-meditators ($p > .78$) (Figure 7.3). In female meditators, there was a trend for the main effect of Prime Valence [$F_{1.97, 31.52} = 2.49$, $p = .10$, $\eta_p^2 = .135$], with a higher %RA following neutral compared with sad primes ($p = .022$) (Figure 7.3). In female non-meditators, there was a trend for a Prime Valence x Pain Type x Pain Condition interaction [$F_{1.42, 22.68} = 3.43$, $p = .06$, $\eta_p^2 = .176$] (Figure 7.3), explained as follows: following sad primes, there was i) higher %RA for emotional painful targets relative to physical painful targets ($p = .061$) and relative to emotional non-painful targets ($p = .004$), ii) higher %RA for physical non-painful relative to emotional non-painful targets ($p = .001$), and iii) higher %RA for physical non-painful relative to physical painful ($p = .021$); following happy primes, there was higher %RA for physical non-painful relative to emotional non-painful target ($p = .001$).

Figure 7.3. Percentage Response Accuracy (%RA) for physical and emotional painful/non-painful targets in male and female Meditators and Non-meditators for the *Affective Priming (AP)* paradigm following primes of happy, neutral and sad primes. Solid bar display RA for detecting targets displaying pain and patterned bars display RT for detecting non-painful targets.



Error bars represent +/- 1 standard error of the mean.

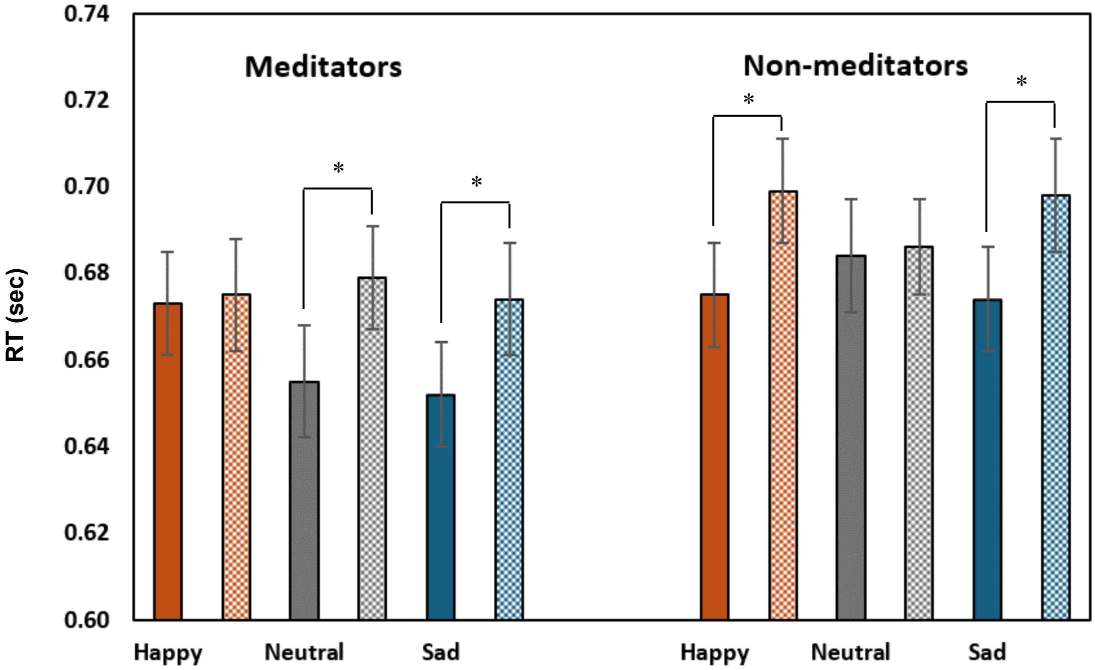
7.3.3.2 *Reaction Time (RT)*

There was a main effect of Pain Condition [$F_{1, 99} = 4.77, p = .032, \eta_p^2 = .045$], with shorter RTs to targets displaying painful relative to non-painful targets. There was also a significant Pain Type x Pain Condition interaction [$F_{1, 99} = 5.37, p = .022, \eta_p^2 = .051$], with pairwise comparisons showing shorter RTs to emotional painful targets relative to physical painful targets, and longer RTs to emotional non-painful targets than physical non-painful targets (all *p* values < .001). There was a significant Prime Valence × Pain Condition x Group interaction [$F_{1.69, 159.002} = 5.32, p = .01, \eta_p^2 = .051$], with pairwise comparisons showing significantly shorter RTs to painful relative to non-painful targets following neutral and sad (but not happy) primes in meditators, as well as happy and sad (but not neutral) primes in non-meditators (all *p* values < .006) (Figure 7.4-A). Pairwise comparisons showed no effect of Pain Condition for each Prime Valence separately ($p > .112$). Lower-order rmANCOVAs were performed separately for each Pain Condition to further investigate Prime Valence x Pain Condition x Group interaction. For painful targets, there was a significant Prime Valence x Group interaction following happy and sad primes [$F_{1, 101} = 4.61, p = .034, \eta_p^2 = .044$] and following happy and neutral primes [$F_{1, 101} = 6.70, p = .011, \eta_p^2 = .062$]. For non-painful targets, there was a significant Prime Valence x Group interaction following happy and neutral primes [$F_{1, 101} = 6.82, p = .010, \eta_p^2 = .063$] and following sad and neutral primes [$F_{1, 101} = 6.38, p = .013, \eta_p^2 = .059$]. Significant lower-order rmANCOVA (Prime Valence x Group) interactions were followed up with pairwise comparisons for Prime Valence using univariate ANCOVAs with Group as a between-subjects factor performed separately for each Pain Condition (Painful vs Non-Painful). Meditators had shorter RTs relative to non-meditators for painful targets following sad primes [$F_{1, 101} = 3.49, p = .065, \eta_p^2 = .033$] and neutral primes [$F_{1, 101} = 4.32, p = .04, \eta_p^2 = .041$] as well as for non-painful targets following happy primes [$F_{1, 101} = 3.77, p = .055, \eta_p^2 = .036$].

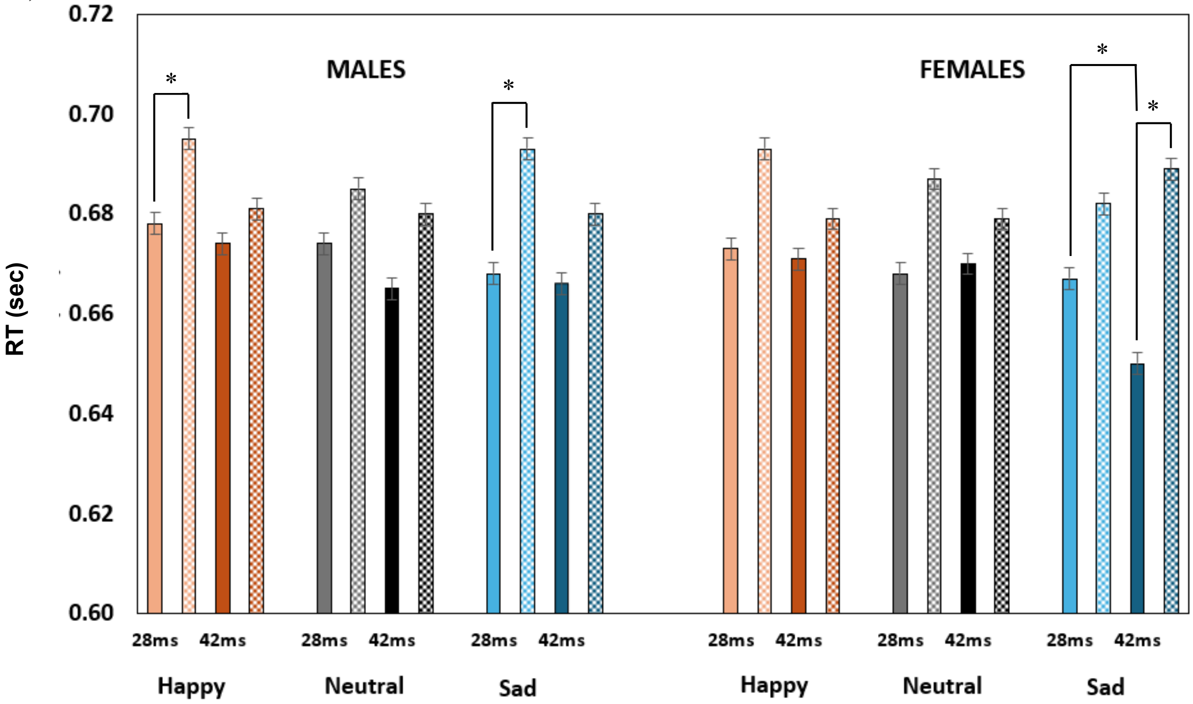
In addition, there was a significant Prime Valence x Prime Duration x Pain Condition x Sex interaction [$F_{1.95, 193.07} = 3.45, p = .035, \eta_p^2 = .034$], explained by significantly shorter RTs to painful relative to non-painful targets following 28-ms happy and sad primes in males (*p* values < .05), and shorter RTs to painful relative to non-painful targets following 42-ms sad primes in females, with shorter RTs following 42-ms relative to 28-ms sad primes overall (*p* values < .05) (Figure 7.4-B). There were no differences between males and females following happy or sad primes as, with no significant main effect of Sex separately for happy or sad primes when following up with univariate ANCOVAs. Age was a significant covariate [$F_{1, 99} = 5.81$, $p = .018$, $\eta_p^2 = .055$], with longer RTs with increasing age.

Figure 7.4. Reaction Time (RT in sec) in the *Affective Priming (AP)* paradigm following happy, neutral and sad prime valence in Meditators and Non-meditators (A), and in males and females with 28-ms and 42-ms prime duration (B),. Solid bars display RT for detecting painful targets and patterned bars display RT for detecting non-painful targets.

A)



B)



Error bars represent +/- 1 standard error of the mean.

7.3.4 *Relationship of Affective Priming Magnitude with NAB and EAB Magnitude*

Spearman correlation coefficients and *p* values for all correlations of %*AP* with *%NAB* and *%EAB* at all lags are presented in Tables 7.3 and 7.4. The main text below focuses on the correlations for the *AB*-inducing intervals (200 ms and 300 ms).

7.3.4.1 *NAB Paradigm*

Happy primes

At lag 200 ms*, %NAB* was positively associated with *%AP* for happy primes in the physical painful condition (42 ms) in meditators [*r* = .30, *p* = .04] but negatively associated in the physical non-painful condition (42 ms) in the whole sample [*r* = -.26, *p* = .01] and in non-meditators [*r* = -.35, *p* = .01]. *%NAB* at lag 200 ms was also negatively associated with *%AP* in the emotional non-painful condition (42 ms) in OMT meditators [*r* = -.66, *p* = .003]. At lag 300 ms, *%NAB* was negatively associated with *%AP* in the physical painful condition (28 ms) in non-meditators [*r* = -.28, *p* = .05], and in the physical non-painful condition (42 ms) in the whole sample [*r* = -.21, *p* = .04]; but negatively associated with *%AP* in the emotional non-painful condition (42 ms) in OMT meditators [*r* = -.52, *p* = .03] (Table 7.3).

Sad primes

%NAB at lag 200 ms was negatively associated with *%AP* for sad primes in the physical non-painful condition (28 ms) in the whole sample [*r* = -.22, *p* = .03], in the physical painful condition (28 ms) and in the emotional non-painful condition (42 ms) in OMT meditators [*r* = -.56, *p* = .02; *r* = -.59, *p* = .01, respectively]. At lag 300 ms, *%NAB* was negatively associated with *%AP* in the physical painful condition (28 ms) in the whole sample [*r* = -.24, *p* = .02], in meditators [*r* = -.31, *p* = .03] and in OMT meditators [*r* = -.60, *p* = .008]; *%NAB* was also negatively associated with *%AP* in the emotional non-painful condition (42 ms) in OMT meditators [*r* = -.53, *p* = .02] (Table 7.3).

Table 7.3. Relationships between *Affective Priming (%AP)* and *Neutral Attentional Blink (%NAB)* magnitudes in the whole sample, Meditator and Non-meditator groups, as well as Meditation Tradition subgroups: Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT)

NAB		Happy prime								Sad prime							
		Physical				Emotional				Physical				Emotional			
		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful	
Lag (ms)	Group	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms
200	Whole sample (n = 100)	-.02 (.82)	.12 (.23)	-.12 (.24)	-.26 (.01)**	-.07 (.48)	-.09 (.37)	.03 (.77)	-.06 (.55)	-.14 (.16)	.08 (.42)	-.22 (.03)*	-.10 (.35)	-.05 (.61)	-.04 (.73)	-.07 (.52)	.03 (.74)
	Meditators (n = 49)	.04 (.80)	.30 (.04)*	-.13 (.39)	-.16 (.27)	.08 (.60)	-.05 (.71)	-.01 (.96)	-.21 (.14)	-.24 (.10)	-.05 (.74)	-.25 (.09)	-.01 (.92)	-.08 (.58)	-.07 (.65)	-.06 (.67)	-.06 (.69)
	Non-meditators (n = 51)	-.09 (.52)	-.05 (.75)	-.11 (.44)	-.35 (.01)*	-.22 (.12)	-.13 (.37)	.08 (.57)	.08 (.58)	-.02 (.88)	.21 (.14)	-.21 (.15)	-.19 (.18)	-.02 (.88)	.01 (.92)	-.06 (.67)	-.02 (.87)
	MaSD (n = 31)	.11 (.54)	.33 (.07)	-.05 (.79)	-.19 (.29)	.24 (.19)	-.04 (.83)	-.09 (.64)	-.07 (.72)	-.12 (.51)	-.14 (.46)	-.17 (.35)	.04 (.85)	-.01 (.96)	-.11 (.56)	-.12 (.53)	.13 (.49)
	OMT (n = 18)	-.23 (.37)	.13 (.62)	-.40 (.10)	.12 (.64)	-.46 (.05)	.00 (.98)	.13 (.60)	-.66 (.003)**	-.56 (.02)*	.35 (.15)	-.33 (.19)	.00 (.98)	-.37 (.14)	.12 (.65)	-.01 (.97)	-.59 (.01)*
300	Whole sample (n = 100)	-.06 (.53)	.13 (.21)	-.11 (.28)	-.21 (.04)*	-.11 (.29)	-.10 (.32)	.04 (.70)	.05 (.61)	-.24 (.02)*	.14 (.17)	-.14 (.16)	-.15 (.14)	-.01 (.96)	.07 (.51)	.08 (.44)	.01 (.89)
	Meditators (n = 49)	.15 (.29)	.21 (.16)	-.15 (.32)	-.14 (.34)	-.04 (.78)	-.07 (.62)	-.04 (.81)	-.15 (.29)	-.31 (.03)*	-.00 (.98)	-.17 (.24)	-.08 (.59)	-.13 (.37)	.01 (.97)	.12 (.42)	-.11 (.45)
	Non-meditators (n = 51)	-.28 (.05)*	.05 (.07)	-.09 (.54)	-.27 (.06)	-.19 (.18)	-.13 (.38)	.12 (.42)	.23 (.11)	-.18 (.21)	.26 (.07)	-.11 (.43)	-.23 (.10)	.10 (.47)	.15 (.30)	.05 (.74)	.10 (.51)
	MaSD (n = 31)	.17 (.37)	.17 (.36)	-.04 (.82)	-.25 (.18)	.11 (.55)	-.10 (.59)	-.08 (.68)	.07 (.71)	-.14 (.46)	-.12 (.52)	-.18 (.32)	-.15 (.41)	-.13 (.49)	-.05 (.79)	.13 (.47)	.09 (.63)
	OMT (n = 18)	.09 (.71)	.26 (.30)	-.40 (.10)	.26 (.30)	-.45 (.06)	.05 (.85)	.06 (.81)	-.52 (.03)*	-.60 (.008)**	.29 (.24)	-.05 (.83)	.09 (.72)	-.15 (.56)	.17 (.50)	.13 (.61)	-.53 (.02)*
400	Whole sample (n = 100)	-.05 (.63)	.13 (.19)	-.21 (.04)*	-.10 (.31)	-.11 (.28)	-.02 (.82)	-.08 (.41)	-.03 (.77)	-.19 (.06)	.17 (.09)	-.07 (.50)	-.21 (.03)*	-.13 (.21)	.13 (.20)	-.08 (.46)	-.08 (.44)
	Meditators (n = 49)	.12 (.41)	.18 (.22)	-.25 (.09)	-.12 (.42)	-.14 (.32)	-.08 (.59)	-.15 (.31)	-.21 (.15)	-.13 (.37)	.09 (.54)	-.16 (.26)	-.26 (.08)	-.25 (.08)	-.07 (.62)	-.10 (.48)	-.18 (.23)
	Non-meditators (n = 51)	-.22 (.12)	.08 (.56)	-.20 (.15)	-.08 (.58)	-.07 (.63)	.02 (.91)	-.02 (.90)	.18 (.22)	-.27 (.06)	.26 (.06)	.01 (.96)	-.16 (.26)	.02 (.90)	.39 (<.001)**	-.05 (.75)	.02 (.88)
	MaSD (n = 31)	.10 (.60)	.11 (.56)	-.19 (.31)	-.11 (.55)	-.07 (.71)	-.17 (.36)	-.10 (.60)	.03 (.89)	-.15 (.43)	.05 (.77)	-.15 (.43)	-.31 (.09)	-.22 (.24)	-.15 (.41)	-.08 (.68)	-.09 (.61)
	OMT (n = 18)	.07 (.77)	.31 (.21)	-.40 (.10)	-.09 (.71)	-.39 (.11)	.11 (.65)	-.31 (.22)	-.54 (.02)*	-.11 (.66)	.28 (.27)	-.23 (.35)	-.12 (.63)	-.38 (.12)	.06 (.82)	-.27 (.28)	-.30 (.23)

NAB		Happy prime								Sad prime							
		Physical				Emotional				Physical				Emotional			
		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful	
Lag (ms)	Group	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms
	Whole sample (n = 100)	.01 (.94)	.19 (.06)	-.20 (.05)*	-.11 (.29)	-.12 (.22)	-.06 (.58)	-.01 (.93)	.01 (.93)	-.22 (.03)*	.15 (.15)	-.22 (.03)*	-.25 (.01)*	-.07 (.52)	.08 (.46)	-.04 (.66)	-.02 (.85)
	Meditators (n = 49)	.21 (.16)	.35 (.01)*	-.33 (.02)*	-.17 (.25)	-.02 (.90)	.06 (.70)	-.17 (.26)	-.25 (.09)	-.13 (.37)	.05 (.76)	-.23 (.12)	-.20 (.16)	-.09 (.52)	-.02 (.91)	-.09 (.53)	-.05 (.71)
500	Non-meditators (n = 51)	-.20 (.15)	.03 (.84)	-.12 (.41)	-.08 (.59)	-.24 (.09)	-.19 (.18)	.14 (.31)	.20 (.16)	-.29 (.04)*	.26 (.07)	-.20 (.16)	-.26 (.06)	.00 (.98)	.20 (.15)	.02 (.88)	.01 (.94)
	MaSD (n = 31)	.32 (.08)	.27 (.14)	-.35 (.05)	-.16 (.38)	.11 (.54)	.01 (.96)	-.08 (.68)	-.12 (.53)	.02 (.91)	-.06 (.75)	-.27 (.14)	-.17 (.37)	-.05 (.81)	-.10 (.61)	-.04 (.84)	-.02 (.93)
	OMT (n = 18)	-.04 (.86)	.46 (.05)	-.31 (.21)	-.22 (.39)	-.28 (.27)	.18 (.47)	-.38 (.12)	-.46 (.05)	-.39 (.11)	.41 (.09)	-.13 (.61)	-.27 (.27)	-.19 (.45)	.15 (.54)	-.27 (.29)	-.10 (.70)
	Whole sample (n = 100)	-.09 (.38)	.11 (.28)	-.20 (.05)	-.09 (.35)	.04 (.68)	.04 (.69)	.02 (.85)	.07 (.50)	-.24 (.02)*	.11 (.28)	-.11 (.28)	-.12 (.23)	-.05 (.60)	.10 (.30)	-.01 (.94)	.08 (.44)
	Meditators (n = 49)	.13 (.39)	.05 (.73)	-.27 (.07)	-.03 (.84)	-.01 (.94)	-.09 (.55)	-.07 (.63)	-.00 (.98)	-.10 (.48)	.04 (.78)	-.21 (.16)	-.01 (.97)	-.15 (.31)	-.18 (.21)	-.11 (.44)	-.04 (.81)
700	Non-meditators (n = 51)	-.30 (.03)*	.15 (.29)	-.15 (.28)	-.16 (.27)	.05 (.71)	.13 (.38)	.08 (.56)	.11 (.45)	-.35 (.01)*	.19 (.19)	-.02 (.89)	-.25 (.07)	.06 (.67)	.45 (<.001)***	.10 (.51)	.18 (.21)
	MaSD (n = 31)	.14 (.44)	.06 (.75)	-.22 (.24)	-.10 (.60)	.10 (.58)	-.05 (.80)	-.09 (.63)	.19 (.30)	-.15 (.43)	-.01 (.96)	-.15 (.44)	-.18 (.34)	-.04 (.83)	-.15 (.42)	.01 (.94)	.10 (.57)
	OMT (n = 18)	.07 (.79)	.12 (.64)	-.47 (.05)*	.17 (.51)	-.38 (.12)	-.24 (.35)	-.08 (.75)	-.29 (.24)	-.03 (.92)	.15 (.54)	-.45 (.06)	.30 (.23)	-.44 (.07)	-.28 (.25)	-.37 (.14)	-.36 (.14)

Notes: * Correlation is significant at the .05 level ($p < .05$); ** Correlation is significant at the .01 level ($p < .01$). The *alpha* level for the correlations as per hypothesis-testing was maintained at .05 ($p < .05$) and adjusted to an *alpha* level of $p < .01$ for the correlations that were exploratory/ not predicted.

7.3.4.2 *EAB Paradigm*

Happy primes

At lag 200 ms, *%EAB* (emotional condition) was negatively associated with *%AP* for 28-ms happy primes in meditators [$r = -.32$, $p = .02$] and MaSD group [$r = -.36$, $p = .05$] in the physical non-painful condition (28 ms), as well as in non-meditators [$r = -.28$, $p = .04$] in the emotional painful condition (28 ms). There was also a significant correlation of *%EAB* for neutral condition with *%AP* for 42-ms happy primes in non-meditators [$r = -.40$, $p = .003$] in the emotional painful.

At lag 300 ms, *%EAB* (emotional) was positively associated with *%AP* in the emotional non-painful condition (28 ms) in MaSD meditators [$r = .35$, $p = .05$] but negatively associated with *%AP* in OMT meditators [$r = -.26$, $p = .31$] (Table 7.4). *%EAB* (neutral) was negatively associated with *%AP* for 28-ms happy primes in the physical non-painful condition in meditators [$r = -.31$, $p = .03$] but positively associated with *%AP* for 42-ms happy primes in the emotional non-painful condition in non-meditators [$r = .30$, $p = .03$] (Table 7.4).

Sad primes

No significant associations between *%EAB* (either emotional or neutral condition) and *%AP* for sad primes were found at lag 200 ms.

At lag 300 ms, %*EAB* (emotional) was positively associated with *%AP* for 42-ms sad primes in the physical painful condition in non-meditators [$r = .28$, $p = .04$] (Table 7.4).*%EAB* (neutral) was negatively associated with *%AP* for 28-ms sad primes in the physical non-painful condition in meditators [$r = -.34$, $p = .02$], but positively associated with *%AP* for 42-ms sad primes in the physical painful condition in non-meditators [$r = .28$, $p = .04$] (Table 7.4).

Table 7.4. Relationships between *Affective Priming magnitude (%AP)* and *Emotional Attentional Blink magnitude (%EAB)* in the whole sample, Meditator, Non-meditator groups, Meditation Tradition subgroups: Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT)

EAB *Neutral*		Happy prime								Sad prime							
		Physical				Emotional				Physical				Emotional			
		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful	
Lag (ms)	Group	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms
200	Whole sample (n = 103)	.04 (.71)	.09 (.36)	-.04 (.67)	.12 (.23)	-.001 (.99)	-.09 (.38)	-.03 (.76)	.11 (.27)	-.17 (.08)	.07 (.47)	-.19 (.05)	.13 (.19)	-.02 (.86)	-.02 (.87)	-.13 (.21)	-.04 (.73)
	Meditators (n = 49)	-.07 (.62)	.15 (.31)	-.05 (.72)	.16 (.27)	.11 (.47)	.19 (.19)	.004 (.98)	-.02 (.89)	-.28 (.06)	-.05 (.74)	-.18 (.21)	.16 (.27)	-.02 (.89)	.04 (.78)	-.03 (.85)	-.02 (.92)
	Non-meditators (n = 54)	.16 (.26)	.03 (.81)	-.04 (.80)	.08 (.59)	-.12 (.37)	-.40 (.003)**	-.05 (.75)	.22 (.11)	-.06 (.67)	.19 (.16)	-.20 (.16)	.12 (.39)	-.02 (.88)	-.08 (.56)	-.20 (.15)	-.06 (.66)
	MaSD (n = 31)	-.02 (.92)	.09 (.65)	-.02 (.94)	.13 (.49)	.21 (.25)	.19 (.31)	.15 (.41)	.10 (.58)	-.18 (.34)	-.17 (.35)	-.19 (.31)	.25 (.18)	.12 (.53)	.05 (.81)	.02 (.93)	.12 (.51)
	OMT (n = 18)	-.20 (.42)	.31 (.21)	-.26 (.30)	.26 (.30)	-.10 (.69)	.17 (.51)	-.23 (.35)	-.17 (.50)	-.45 (.06)	.29 (.24)	-.25 (.32)	-.06 (.82)	-.30 (.23)	.02 (.94)	-.09 (.74)	-.26 (.30)
300	Whole sample (n = 103)	.06 (.54)	.07 (.50)	-.16 (.12)	.08 (.42)	-.06 (.54)	-.08 (.42)	.13 (.18)	.12 (.22)	-.14 (.17)	.11 (.26)	-.15 (.14)	.10 (.30)	-.08 (.40)	-.002 (.99)	-.03 (.74)	-.12 (.23)
	Meditators (n = 49)	-.04 (.80)	-.09 (.52)	-.31 (.03)*	.22 (.12)	.06 (.69)	.14 (.36)	.05 (.74)	-.04 (.79)	-.21 (.14)	-.12 (.42)	-.34 (.02)*	.14 (.33)	-.00 (.99)	-.08 (.58)	-.07 (.64)	-.13 (.39)
	Non-meditators (n = 54)	.16 (.24)	.21 (.14)	-.08 (.57)	-.01 (.93)	-.13 (.37)	-.26 (.06)	.20 (.16)	.30 (.03)*	-.06 (.67)	.28 (.04)*	-.07 (.63)	.09 (.50)	-.14 (.32)	.05 (.71)	-.02 (.87)	-.09 (.53)
	MaSD (n = 31)	-.03 (.86)	-.16 (.38)	-.28 (.13)	.19 (.30)	.18 (.35)	.13 (.48)	.28 (.13)	.22 (.23)	-.06 (.74)	-.25 (.17)	-.32 (.08)	.13 (.47)	.14 (.44)	-.13 (.50)	.10 (.60)	.01 (.95)
	OMT (n = 18)	-.02 (.94)	.11 (.66)	-.40 (.10)	.40 (.10)	-.24 (.34)	.07 (.78)	-.34 (.17)	-.27 (.28)	-.43 (.07)	.16 (.52)	-.43 (.07)	.08 (.74)	-.29 (.25)	-.08 (.74)	-.33 (.18)	-.32 (.19)
500	Whole sample (n = 103)	-.06 (.57)	-.03 (.76)	-.17 (.10)	.09 (.38)	-.14 (.17)	-.04 (.67)	.15 (.14)	.15 (.12)	-.22 (.03)*	.08 (.45)	-.23 (.02)*	-.07 (.49)	-.16 (.11)	-.02 (.88)	.01 (.94)	-.14 (.16)
	Meditators (n = 49)	-.04 (.81)	-.10 (.50)	-.12 (.41)	.12 (.42)	-.09 (.53)	.16 (.27)	.02 (.92)	.00 (.98)	-.21 (.15)	-.12 (.41)	-.34 (.02)*	-.18 (.22)	-.17 (.23)	-.11 (.46)	-.02 (.89)	-.18 (22)
	Non-meditators (n = 54)	-.09 (.51)	.04 (.80)	-.21 (.13)	.06 (.66)	-.16 (.26)	-.20 (.14)	.26 (.06)	.36 (.007)**	-.26 (.06)	.24 (.08)	-.18 (.20)	.01 (.94)	-.18 (.20)	.11 (.43)	.02 (.88)	-.10 (.47)
	MaSD (n = 31)	-.16 (.40)	-.01 (.96)	-.12 (.52)	.06 (.74)	-.06 (.73)	.12 (.54)	.23 (.22)	.35 (.05)	-.18 (.32)	-.15 (.44)	-.29 (.12)	-.23 (.22)	-.17 (.37)	-.20 (.27)	.19 (.31)	.07 (.71)
	OMT (n = 18)	.27 (.28)	-.25 (.31)	-.12 (.64)	.30 (.22)	-.18 (.49)	.25 (.33)	-.45 (.06)	-.41 (.09)	-.17 (.49)	-.13 (.61)	-.47 (.05)*	-.11 (.66)	-.19 (.45)	.05 (.86)	-.48 (.04)*	-.52 (.03)*
700	Whole sample (n = 103)	.08 (.45)	.03 (.77)	-.24 (.02)*	-.10 (.34)	-.07 (.47)	.03 (.78)	.04 (.67)	.01 (.92)	-.12 (.24)	.15 (.13)	-.28 (.004)**	-.09 (.38)	-.11 (.27)	-.01 (.92)	.04 (.66)	-.04 (.67)
	Meditators (n = 49)	.26 (.08)	.15 (.30)	-.24 (.10)	.03 (.84)	-.01 (.92)	.18 (.21)	-.15 (.31)	-.17 (.25)	-.14 (.33)	.12 (.40)	-.28 (.05)	.02 (.91)	-.14 (.33)	-.05 (.72)	-.08 (.57)	-.12 (40)
	Non-meditators (n = 54)	-.08 (.55)	-.07 (.64)	-.25 (.07)	-.19 (.17)	-.10 (.48)	-.09 (.52)	.20 (.14)	.20 (.15)	-.12 (.41)	.18 (.20)	-.30 (.03)*	-.20 (.14)	-.10 (.50)	.05 (.72)	.14 (.31)	.05 (.75)
	MaSD (n = 31)	.20 (.29)	.25 (.18)	-.26 (.15)	-.06 (.76)	.20 (.28)	.20 (.28)	-.14 (.47)	-.02 (.90)	-.06 (.76)	.20 (.28)	-.22 (.23)	.03 (.89)	-.04 (.83)	-.09 (.65)	-.03 (.89)	-.06 (.73)
	OMT (n = 18)	.39 (.11)	-.04 (.88)	-.16 (.51)	.33 (.18)	-.37 (.13)	.18 (.48)	-.23 (.37)	-.34 (.17)	-.23 (.37)	-.10 (.70)	-.39 (.11)	.00 (.99)	-.28 (.27)	.02 (.93)	-.27 (.28)	-.18 (.48)

EAB *Emotional*		Happy prime								Sad prime							
		Physical				Emotional				Physical				Emotional			
		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful	
Lag (ms)	Group	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms
200	Whole sample (n = 103)	.05 (.63)	-.02 (.86)	-.06 (.57)	.17 (.09)	.-17 (.09)	-.05 (.62)	.02 (.88)	-.01 (.90)	-.09 (.36)	.09 (.38)	-.15 (.13)	.11 (.26)	-.08 (.45)	-.00 (.98)	.03 (.76)	-.09 (.38)
	Meditators (n = 49)	.04 (.80)	-.02 (.90)	-.32 (.02)*	.21 (.15)	-.02 (.88)	.13 (.36)	.02 (.90)	-.21 (.15)	-.23 (.12)	-.07 (.64)	-.25 (.09)	.18 (.22)	-.05 (.75)	-.03 (.84)	.04 (.77)	-.16 (.26)
	Non-meditators (n = 54)	.05 (.71)	.00 (.99)	.09 (.51)	.16 (.26)	-.28 (.04)*	-.23 (.09)	.01 (.93)	.15 (.27)	.02 (.88)	.25 (.07)	-.08 (.55)	.07 (.63)	-.12 (.41)	.02 (.88)	-.01 (.92)	-.06 (.69)
	MaSD (n = 31)	.16 (.39)	-.04 (.81)	-.36 (.05)*	.16 (.39)	.08 (.69)	.11 (.57)	.25 (.18)	-.11 (.57)	-.16 (.40)	-.11 (.55)	-.21 (.25)	.21 (.26)	.16 (.40)	-.07 (.72)	.28 (.13)	-.09 (.64)
	OMT (n = 18)	-.17 (.51)	.01 (.98)	-.30 (.22)	.33 (.18)	-.19 (.46)	.22 (.38)	-.41 (.09)	-.34 (.17)	-.32 (.20)	-.03 (.90)	-.34 (.16)	.07 (.77)	-.39 (.11)	.05 (.84)	-.40 (.10)	-.29 (.24)
300	Whole sample (n = 103)	.06 (.54)	.02 (.87)	-.10 (.30)	.01 (.96)	.03 (.80)	-.07 (.46)	.08 (.42)	.03 (.79)	-.10 (.33)	.11 (.29)	-.18 (.06)	.12 (.23)	.13 (.18)	-.004 (.97)	-.02 (.86)	-.03 (.77)
	Meditators (n = 49)	.13 (.37)	-.12 (.40)	-.22 (.12)	.12 (.40)	.11 (.47)	.16 (.26)	.14 (.33)	-.02 (.89)	-.10 (.51)	-.14 (.35)	-.27 (.06)	.10 (.50)	.13 (.37)	.01 (.96)	-.05 (.76)	-.10 (.49)
	Non-meditators (n = 54)	.005 (.97)	.13 (.36)	-.06 (.66)	-.08 (.59)	-.01 (.92)	-.27 (.05)	.04 (.76)	.11 (.43)	-.10 (.48)	.28 (.04)*	-.14 (.31)	.13 (.35)	.13 (.35)	.00 (.99)	-.02 (.91)	.03 (.83)
	MaSD (n = 31)	.05 (.81)	-.08 (.68)	-.22 (.25)	.05 (.80)	.10 (.60)	.21 (.26)	.35 (.05)	.10 (.58)	-.05 (.79)	-.19 (.30)	-.21 (.25)	.09 (.63)	.14 (.44)	.05 (.80)	.11 (.54)	.05 (.79)
	OMT (n = 18)	.27 (.28)	-.18 (.48)	-.26 (.30)	.40 (.10)	.08 (.75)	.05 (.85)	-.26 (.31)	-.18 (.47)	-.20 (.43)	-.06 (.80)	-.44 (.07)	.07 (.80)	.11 (.66)	-.03 (.89)	-.35 (.15)	-.37 (.13)
500	Whole sample (n = 103)	.11 (.28)	.02 (.87)	-.16 (.10)	-.02 (.83)	.02 (.86)	.08 (.44)	.07 (.49)	.10 (.30)	-.06 (.53)	.08 (.43)	-.22 (.03)*	-.04 (.70)	-.09 (.39)	.04 (.69)	.10 (.34)	-.08 (.41)
	Meditators (n = 49)	.12 (.40)	.02 (.87)	-.18 (.21)	.01 (.95)	.05 (.75)	.27 (.06)	-.15 (.30)	-.15 (.32)	-.13 (.38)	-.02 (.88)	-.15 (.30)	-.11 (.44)	-.12 (.42)	.05 (.73)	.03 (.85)	-.15 (.31)
	Non-meditators (n = 54)	.10 (.47)	.02 (.90)	-.16 (.24)	-.05 (.75)	.02 (.91)	-.07 (.59)	.23 (.10)	.35 (.01)*	-.02 (.88)	.15 (.27)	-.29 (.04)*	.02 (.88)	-.05 (.70)	.05 (.73)	.15 (.27)	-.03 (.83)
	MaSD (n = 31)	.13 (.49)	.15 (.43)	-.18 (.33)	-.06 (.74)	.08 (.66)	.36 (.05)*	-.09 (.62)	-.01 (.95)	.00 (.99)	-.02 (.90)	-.04 (.82)	-.10 (.60)	-.17 (.37)	.05 (.80)	.19 (.32)	-.02 (.92)
	OMT (n = 18)	.13 (.62)	-.16 (.54)	-.30 (.22)	.21 (.40)	-.05 (.86)	.13 (.61)	-.27 (.27)	-.30 (.23)	-.30 (.23)	.05 (.85)	-.37 (.13)	-.12 (.64)	-.03 (92)	.08 (.76)	-.25 (.31)	-.38 (.12)
700	Whole sample (n = 103)	.04 (.66)	.04 (.69)	-.15 (.14)	-.08 (.45)	.04 (.66)	.08 (.43)	.07 (.51)	.06 (.55)	-.14 (.15)	.03 (.75)	-.24 (.02)*	-.05 (.59)	-.07 (.46)	.02 (.81)	.07 (.48)	-.02 (.88)
	Meditators (n = 49)	.14 (.34)	-.02 (.90)	-.17 (.25)	-.03 (.84)	.11 (.46)	.27 (.07)	-.20 (.17)	-.22 (.14)	-.14 (.34)	-.13 (.38)	-.27 (.07)	-.10 (.49)	-.06 (.68)	.09 (.56)	-.03 (.85)	-.17 (.25)
	Non-meditators (n = 54)	.002 (.99)	.08 (.55)	-.14 (.31)	-.11 (.44)	-.02 (.87)	-.11 (.42)	.27 (.05)*	.30 (.03)*	-.13 (.34)	.20 (.15)	-.22 (.11)	.03 (.81)	-.08 (.54)	-.03 (.84)	.15 (.28)	.11 (.45)
	MaSD (n = 31)	.11 (.57)	.13 (.48)	-.14 (.45)	-.14 (.46)	.27 (.14)	.34 (.06)	-.05 (.80)	-.04 (.82)	-.02 (.90)	-.18 (.32)	-.20 (.28)	-.03 (.88)	-.01 (.96)	.13 (.48)	.18 (.34)	.04 (.81)
	OMT (n = 18)	.18 (.46)	-.20 (.42)	-.27 (.28)	.24 (.33)	-.12 (.64)	.10 (.69)	-.50 (.04)*	-.42 (.09)	-.23 (.35)	-.03 (.89)	-.43 (.08)	-.22 (.37)	-.15 (.54)	-.01 (.98)	-.41 (.09)	-.47 (.05)*

Notes: * Correlation is significant at the .05 level ($p < .05$); ** Correlation is significant at the .01 level ($p < .01$). The *alpha* level for the correlations as per hypothesis-testing was maintained at .05 ($p < .05$) and adjusted to an *alpha* level of $p < .01$ for the correlations that were exploratory/ not predicted.

7.3.5 *Relationship of Affective Priming Magnitude with Trait Equanimity and Non-reactivity*

Happy primes

In the physical painful condition with 28-ms happy primes, lower *%AP* for was significantly associated with higher NAS-7 (*equanimity*) scores in meditators [$r = -.30$, $p = .04$] and in OMT meditators ($r = -.57$, $p = .01$], as well as higher FFMQ (*non-reactivity*) in meditators [$r = -.35$, $p = .01$]. For 42-ms happy primes, lower *%AP* was significantly associated with higher FFMQ (*non-reactivity*) scores in meditators [$r = -.38$, $p = .008$] and MaSD subgroup [$r = -.43$, $p = .02$] in the physical painful condition as well as in meditators [$r = .29$, $p = .04$] in the physical non-painful condition (Table 7.5).

Sad primes

In the physical non-painful condition with 28-ms sad primes, lower *%AP* was associated with lower NAS-7 (*equanimity*) scores in meditators [$r = .31$, $p = .03$] and MaSD subgroup [$r = .40$, $p = .03$], but with higher NAS-7 scores in non-meditators [$r = -.29$, $p = .04$]. In the emotional non-painful condition with 42-ms sad primes, lower *%AP* was associated with higher FFMQ (*non-reactivity*) scores in the whole sample [$r = -.23$, $p = .02$] and in MaSD subgroup [$r = -.36$, $p = .05$] (Table 7.5).

Table 7.5. Relationships of *Affective Priming Magnitude (%AP)* with trait *Non-Reactivity* (FFMQ) and *Equanimity* (NAS-7) in the whole sample, Meditator and Non-meditator groups, as well as Meditation Tradition subgroups: Mindfulness as Secularly Defined (MaSD) and Other Meditation Traditions (OMT)

Self-Report Measures	Group	Happy prime								Sad prime							
		Physical				Emotional				Physical				Emotional			
		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful		Painful		Non-painful	
		28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms	28ms	42ms
Non-reactivity	Whole sample (n = 104)	-.12 (.22)	.10 (.30)	.12 (.23)	.08 (.42)	.05 (.62)	.03 (.78)	-.12 (.25)	.07 (.50)	-.06 (.57)	-.01 (.96)	.02 (.86)	-.07 (.47)	.02 (.86)	.11 (.29)	-.02 (.81)	-.23 (.02)*
	Meditators (n = 49)	-.35 (.01)*	-.38 (.008)**	.04 (.77)	.29 (.04)*	-.09 (.56)	.11 (.47)	-.25 (.09)	.13 (.38)	-.06 (.69)	-.16 (.27)	.12 (.43)	-.07 (.62)	-.22 (.14)	.12 (.40)	-.13 (.36)	-.26 (.08)
	Non-meditators (n = 55)	.07 (.59)	.15 (.29)	.16 (.25)	-.10 (.48)	.19 (.18)	.01 (.93)	-.00 (1.00)	.06 (.66)	-.06 (.65)	.11 (43)	-.08 (.56)	-.11 (.43)	.23 (.10)	.10 (.50)	.07 (.64)	-.19 (.17)
	MaSD (n = 31)	-.30 (.10)	-.43 (.02)*	.13 (.47)	.29 (.11)	-.26 (.16)	.01 (.97)	-.23 (.21)	.03 (.86)	.04 (.85)	-.26 (.16)	.26 (.15)	-.10 (.61)	-.29 (.12)	.13 (.48)	-.12 (.53)	-.36 (.05)*
	OMT (n = 18)	-.47 (.05)	-.30 (.23)	-.31 (.22)	.35 (.15)	.32 (.20)	.24 (.34)	-.28 (.26)	.23 (.37)	-.22 (.39)	.13 (.61)	-.38 (.12)	-.03 (.90)	-.06 (.81)	.03 (.92)	-.15 (.56)	-.12 (.63)
Equanimity	Whole sample (n = 104)	-.02 (.86)	-.02 (.82)	-.02 (.82)	-.06 (.55)	.04 (.69)	-.02 (.88)	-.06 (.53)	-.00 (.99)	-.11 (.26)	-.05 (.65)	-.01 (.90)	-.02 (.82)	.04 (.70)	.12 (.22)	.06 (.58)	-.13 (.21)
	Meditators (n = 49)	-.30 (.04)*	-.04 (.81)	.14 (.36)	-.03 (.85)	.01 (.95)	.12 (.43)	-.12 (.41)	-.10 (.51)	-.20 (.18)	-.11 (.45)	.31 (.03)*	-.04 (.79)	-.14 (.35)	.26 (.07)	.13 (.36)	-.02 (.89)
	Non-meditators (n = 55)	.24 (.08)	-.01 (.97)	-.12 (.41)	-.09 (.52)	.10 (.47)	-.11 (.43)	.00 (.99)	15 (.29)	-.05 (.71)	.01 (.93)	-.29 (.04)*	-.04 (.80)	.19 (.16)	-.05 (.72)	-.03 (.84)	-.21 (.12)
	MaSD (n = 31)	-.16 (.38)	-.19 (.31)	.25 (.17)	-.05 (.77)	-.07 (.70)	.06 (.74)	-.14 (.46)	-.26 (.15)	-.14 (.47)	-.26 (.16)	.40 (.03)*	-.17 (.36)	-.26 (.16)	.28 (.12)	.23 (.21)	-.16 (.41)
	OMT (n = 18)	-.57 (.01)*	.23 (.37)	-.21 (.40)	.02 (.93)	.15 (.55)	.21 (.40)	-.07 (.78)	.10 (.70)	-.30 (.23)	.26 (.30)	.09 (.73)	.12 (.63)	.07 (.80)	.23 (.37)	-.05 (.85)	.16 (.52)

Notes: * Correlation is significant at the .05 level ($p < .05$); ** Correlation is significant at the .01 level ($p < .01$). The *alpha* level for the correlations as per hypothesis-testing was maintained at .05 ($p < .05$) and adjusted to an *alpha* level of $p < .01$ for the correlations that were exploratory/ not predicted.

7.4 Discussion

The current study was the first to investigate the effects of meditation practice on emotional processing using the *AP* paradigm in meditators and non-meditators, in addition to exploring sex differences in *AP* performance. The study also explored associations of *AP* with *NAB* and *EAB*, as well as with trait *equanimity* and *non-reactivity*. In line with H1-H2, meditators were comparatively less impacted by prime valence and showed no significant differences in the priming effects in *congruent* vs *incongruent* conditions (happy as compared with sad primes showed no %RA differences), whilst non-meditators showed strong priming effects in *incongruent* condition (significantly lower %RA following happy as compared with neutral primes). In line with H3, sex differences in *AP* paradigm performance revealed the strongest priming effect being predominantly present in female non-meditators (significantly lower %RA following happy as compared with neutral primes) and poorer performance compared with female meditators (lower %RA following happy primes), though no differences found between male and female meditators. Contrary to H4, higher *AP* was associated with lower *EAB* at lag 200 ms and 300 ms for emotional *EAB* in meditators and mindfulness meditators specifically, but with higher *EAB* in non-meditators. In agreement with H5, lower *AP* was associated with higher trait *equanimity* and *non-reactivity* in *incongruent* conditions in the whole sample, meditators (both MaSD and OMT) and non-meditators.

7.4.1 *Meditators vs Non-meditators: Affective Priming Performance (%RA)*

In line with H1-H2, there was no significant priming effect in meditators: evaluation of pain in the targets was not impacted when preceded by happy as compared with sad primes (i.e. no significant %RA differences between *congruent* and *incongruent* conditions). On the contrary, and as expected, non-meditators showed a strong priming effect for *incongruent* conditions: %RA was comparatively lower following happy primes (i.e. *incongruen*t condition) compared with neutral primes, with *incongruent* primes creating an interference when responding to/evaluating painful targets.

The findings are consistent with the view that meditators are less impacted by emotional stimuli, whether of negative or positive in valence. Previous studies have demonstrated an attenuated emotional impact and rating of valence in meditators; Zen meditators rated valence of high-and-low arousing words (positive and negative) as more *neutral* following meditation, relative to controls who showed no changes (Lusnig et al., 2020). Following compassion meditation training, positive and negative emotional images were rated as more *neutral* in valence, and these changes were correlated with structural changes in the prefrontal network of meditators (Chau et al., 2018). Kral et al (2018) showed reduced amygdala activation to both positive and negative images, after short-term and long-term mindfulness meditation, respectively. In a recent EEG study, Brown et al (2022) showed that mindfulness training led to reduced reactivity to emotional images, irrespective of valence type (pleasant or unpleasant). Yet, another study showed that mindfulness reduced perceived emotional intensity from both positive and negative valence images, and encouraged emotional stability (Taylor et al., 2011). The attenuating emotional impact of prime valence within meditators can be suggestively driven by the observational state that is employed during meditative practices which involve fully experiencing and accepting emotional states on a moment-by-moment basis, without self-referential processing (Roemer et al., 2015). Such a state can promote a more adaptive and balanced response to emotional stimuli, instead of automatic, habituative and reactive responses (Bishop et al., 2004). The observed effects in non-meditators are inferred to be *arousal-based*: happy primes did not prime the targets, leading to lower accuracy in evaluating painful targets whereas sad primes primed the target, and consequently lead to a comparatively higher accuracy in evaluation of painful targets.

7.4.2 *Meditators vs Non-meditators: Affective Priming Processing (RT)*

Meditators had faster RTs to painful targets, relative to non-painful, when preceded by sad and neutral primes but showed similar RTs for painful and non-painful targets when preceded by happy primes. In contrast, non-meditators showed faster RTs to painful images, relative to non-painful, when preceded by both happy and sad primes. Thus, non-meditators processed painful images at a similar rate for *congruent* and *incongruent* conditions, suggesting a strong *arousal effect* as well as supporting the *Spreading Theory* (Chapter 3, Section 1.6): both happy and sad primes were highly arousing leading to the activation of associative semantic memory networks and thus impacting the response to the targets depending on the trajectory of associations (congruent vs incongruent) in relation to the targets. However, meditators processed painful images comparatively faster when preceded by sad primes compared with happy primes. It could be suggested that sad faces primed meditators' response to painful images (i.e. faster RTs) due to their faster processing of empathy for pain, since faster processing of painful targets has been associated with affective empathic responses in an *AP* paradigm (Grynberg & Maurage, 2014). However, meditators did not differ significantly from non-meditators on any of the IRI subscales. When processing images of human suffering, Favre et al (2021) demonstrated considerable reductions in experienced negative emotion after completing (affect-based) meditation training, thus, suggesting improved processing of empathy for pain. Further elucidating the current finding, meditators are better at allowing thoughts and feelings that arise in response to emotionally charged stimuli to come and go, without ruminating on them, leading to more efficient stimuli processing (Garland et al., 2015).

7.4.3 *Affective Priming: The Influence of Sex*

In agreement with H3, female non-meditators displayed the strongest prime effect, particularly for *incongruent* conditions (i.e. evaluation of emotional pain was particularly disrupted when preceded by happy primes, relative to sad primes). Female non-meditators also showed weaker performance, compared with female meditators, for *incongruent* conditions. Furthermore, as predicted by H3, no sex differences were observed between male and female meditators.
Current findings in relation to a strong priming effect in female non-meditators is in line with previous literature on emotion processing in females. A review by Whittle et al (2011) showed that, typically, females are more emotionally perceptive (i.e. better in emotion recognition and detection) than males, experience negative emotions with greater intensity, and show higher responsivity (Lithari et al., 2010) and susceptibility to negative affect, even for lower valence strength (Yuan et al., 2009). Males and females also employ different emotion regulation strategies, particularly when processing negative emotions (i.e. females utilise emotion-focused processing, whilst males employ more cognitive strategies). It is therefore possible that females were *more attentive*, and more *equipped*, to detect emotional pain. Another contributing factor to observing the strongest prime effect for painful images in female non-meditators could be the stronger empathy and prosocial tendencies observed in females, relative to males (McDonald & Kanske, 2023). Research has shown that females, compared with males, exhibit higher sensitivity to affective facial expressions (Chen et al., 2018).

Furthermore, females demonstrated faster processing of painful targets, relative to non-painful, when preceded by 42-ms sad primes, as well as faster processing relative to 28-ms sad primes. Males, however, showed no differences when processing painful targets following 28ms and 42-ms duration sad primes. Males did, however, process painful targets faster, relative to non-painful, when preceded by both 28-ms happy and 28-ms sad primes. Findings could possibly reflect sex differences in emotion processing (Whittle et al., 2011): employing cognitive strategies when processing painful targets would have enabled prime valence to be differentially processed in males. In contrast, when females were able to consciously perceive the sad priming stimuli, processing of target stimuli was comparatively faster. In fact, females had the shortest RT when detecting painful targets following 42-ms sad primes. This could further support the view that females are more attentive to emotional pain and, arguably, more empathically attuned to detect painful targets.

7.4.4 *Emotional vs Physical Pain*

Following sad primes, overall performance was comparatively better when detecting *emotional* pain, relative to *physical* pain. Although both pain types were *congruent* conditions, *emotional* pain was responded to faster and more accurately. The nature of the presented stimuli could have also contributed to the observed findings; for *emotional* pain, both primes and targets shared similar visual features (i.e. facial stimuli), unlike the *physical* pain condition, which involved a non-facial stimulus (i.e. face vs hand stimuli). Facial stimuli also carries more emotional information whereas physical (i.e. body) pain is associated with more perceptual information (Li et al., 2019). The images used for the physical pain condition might have also been more ambiguous to interpret in terms of pain/no-pain. Hence, the observed findings could be a result of differential processing following faster, or slower processing, of prime-and-target stimuli pairs for visual features.

7.4.5 *Emotional Attentional Blink and Affective Priming Performance*

Contrary to H4, the pattern of the relationships between *AP* and *EAB* and *AP* was inconsistent and, therefore, difficult to interpret. Whilst non-meditators showed somewhat consistent positive associations between the *AP* and *EAB* paradigm performance, the associations in meditators appear random or in opposite direction to those in non-meditators. *EAB* for lags 200 ms and 300 ms showed positive associations with *AP* in both *congruent* and *incongruent* conditions for non-meditators.

The mixed findings could be a result of how emotional stimuli are processed perceptually in the *AP* and *EAB* paradigms. The *EAB* is considered to be a 'top-down' attentional phenomenon which gets disrupted by 'bottom-up' *attentional capture* (McHugo et al., 2013; Santacroce et al., 2021), thus, combining both stimulus-driven (bottom-up) and goal-directed (top-down) attentional processes. *AP* is considered to be a top-down attentional process (Kristjánsson &

Ásgeirsson, 2019; Wolfe et al., 2003). Bottom-up and top-down attentional systems are independent attentional processes (Katsuki & Constantinidis, 2014) with distinct effects on visual feature processing (Eimer et al., 2009). It is therefore plausible that processing prime valence in the context of the *AP* paradigm performance could be affected by *attentional capture*, similar to emotion saliency of T1 stimuli inducing stronger *EAB*, involving the interplay of both stimulus-driven (bottom-up) and goal-directed (top-down) attentional processes.

However, given that the expected (positive) associations between *AP* and *EAB* were more consistently found in non-meditators and less so for meditators, it could reflect the effects of meditation practices on attentional processes and emotion regulation: in non-meditators, the 'untrained' mind displayed *both* a higher impact of prime valence *and* T1 saliency in *AP* and *EAB* paradigms, respectively. In relation to *NAB*, most associations with *AP* magnitude were negative and demonstrated no particular pattern, which is not surprising considering there was no involvement of emotional stimuli and thus, a positive association between performances was not expected.

7.4.6 *Relationships of Affective Priming Magnitude with Trait Equanimity and Non-reactivity*

In line with H5, better *AP* paradigm performance was associated with higher trait *equanimity* in the physical painful condition with the 28-ms happy primes in meditators and OMT subgroup as well as higher trait *non-reactivity* in the physical painful condition with 42-ms happy prime in MaSD subgroup and in the emotional non-painful condition with 42-ms sad primes in the whole sample and MaSD meditators.

This finding supports the notion that individuals with higher *equanimity* and *non-reactivity* maintain a state of mental steadiness, whereby the affective properties of the prime did not exert a strong priming effect, making them be less impacted by either happy or sad prime valence. Since *equanimity* is observed at higher levels in meditators, with meditation retreatants showing higher *equanimity* (Montero-Marin et al., 2020), this finding is also in agreement with the previously discussed finding of meditators being overall less 'affected' by prime valence (due to perceiving valence as more *neutral*). Indeed, research shows that *equanimity* is associated with a neutral approach towards surroundings (Tremblay et al., 2024; Weber, 2017).

However, there was also an association in an unexpected direction in meditators practicing mindfulness as secularly defined, with stronger *AP* being associated with higher *equanimity* in the physical non-painful condition with 28-ms sad primes (this association was in an expected direction in non-meditators).

7.4.7 *Strengths, Limitations and Future Directions*

This is the first study to investigate the effects of meditation on emotional processing using an *AP* paradigm by comparing meditators and non-meditators. A strength of the study is the inclusion of painful (displaying emotional vs physical pain) and non-painful targets, which also enables to evaluate an interaction with the effects of meditation on processing of the empathy for pain and whether it is affective by primes of positive and negative valence. Secondly, the study utilised two prime durations to differentiate potential priming effects in RT processing of meditators and non-meditators.

However, as a limitation, stimuli used for painful and non-painful targets were not highly varied (per condition). Utilising a wider variety of paired images depicting emotional and physical pain would be advantageous in teasing apart the observed effects even further (e.g. multiple types of emotional pain images). Another limitation of the study was that the non-painful emotional pain image could be perceived ambiguously as a potentially fearful eye expression; hence, future studies should present a clear non-painful emotional condition to enhance *AP* effects and include fearful priming faces to further elucidate *AP* priming effects in meditators and non-meditators. A further limitation of the study is the large number of comparisons and correlations performed without adjustment for multiple tests. The findings, therefore, should be treated as exploratory and replicated in future studies. Findings would also need to be replicated in longitudinal studies since pre-existing individual differences in affective priming prior to taking up meditation practice could not be ruled out in the cross-sectional study design. Future studies should also use more targeted recruitment and approaches to avoid potential self-selection bias, as could be the case in the current study's sample, and aim to compare meditators practicing different meditation approaches/techniques. Also, recruitment of meditators via paid platforms such as TestableMinds does not allow verifying the self-reported meditation practice history, thus future research should use other recruitment strategies.

7.4.8 *Conclusion*

Together, findings indicate that, relative to non-meditators, meditators were less impacted by prime valence during the *AP* paradigm performance. Prime arousal (happy and sad vs neutral), which appears to have made an impact on the performance in non-meditators, did not affect performance in meditators when evaluating painful target stimuli, which might have been driven by a reduced valence perception of primes in meditators. In accordance with previous research, the findings revealed the most prominent priming effect in female non-meditators, but there were no sex differences between female and male meditators in *AP* paradigm performance. Findings highlight *equanimity* and *non-reactivity* as possible mechanisms underlying the effects of meditation practice on attenuating *affective priming*. Overall, the results support positive effects of meditation on emotional regulation by reducing the impact of emotional stimuli.

Chapter 8 : General Discussion

8.1 Overview of Studies

The overarching conceptual and methodological aims of the presented research were to better understand the effects of meditation on attentional capacity, emotion regulation, and sensory information processing using established paradigms indexing *AB*, *PPI* and *AP* effects. The investigation of the relationships of *AB*, *PPI* and *AP* with trait *equanimity* and *non-reactivity* together with the relationships of *AB* with *PPI* and *AP* in meditators and non-meditators aimed at elucidating the mechanisms underlying the effects of meditation on *AB*, including reduced *attentional capture* and associated semantic memory activation, with the direction of the effects on sensory gating being left open. The levels of sensory information processes investigated across the studies ranged from attentive/conscious (*Study 1*) to automatic/pre-attentive (*Study 2*) and to subliminal (*Study 3*).

The first empirical study investigated the effects of meditation on *NAB* and *EAB* using the paradigms that index *attentional capacity* (*NAB* and *EAB*) and emotion regulation (*EAB*) by comparing meditators and non-meditators in a cross-sectional design, with a focus on the role of *attentional capture* as a potential mechanism underlying meditation effects on *AB*. *NAB* and *EAB* magnitudes were investigated in relation to trait *equanimity* and *non-reactivity*. The *NAB* indexed a subject-level 'baseline' measure of *attentional capacity* whereas the *EAB* quantified *attentional capture* by emotionally salient stimuli.

The second empirical study examined the relationships between *PPI* and *AB* to ascertain whether *AB* (particularly *NAB*) might be underlined by sensory gating or filtering, as well as the relationships of *PPI* with trait *non-reactivity* and *equanimity* to determine whether trait *non-reactivity* and *equanimity* developed through meditation have an impact on automatic sensory gating/filtering mechanism.

The third empirical study investigated the effects of meditation on *AP* paradigm performance in meditators and non-meditators (a subsample of *Study 1* participants) to ascertain whether meditation reduces affective bias during sensory information processing. It also examined the relationships of *AP* with *AB* (particularly *EAB)* as well as trait *non-reactivity* and *equanimity*.

8.2 Summary and Implications of Thesis Findings

Study 1 showed no differences between meditators and non-meditators on *AB* paradigm performance but reported the novel finding of higher trait *equanimity* and *non-reactivity* being associated with lower *EAB* in meditators generally and mindfulness meditators specifically. In regard to sensory gating mechanisms investigated in *Study 2*, although there were no differences between meditators and non-meditators in *PPI* magnitude, the novel finding of higher *PPI* being associated with slower RT to correctly identified T2 stimuli during *NAB* paradigm performance deserves further investigation in order to better understand the role of sensory gating/filtering mechanism in *NAB*. *Study 3* provided novel evidence of meditators being significantly less impacted by priming stimuli relative to non-meditators, further highlighting that meditative practices reduce the impact of affective stimuli during sensory information processing, leading to less biased affective information even at subliminal level. Thus, the research reported in this thesis contributed further evidence that meditation practices have enhancing effects on attention capacity and emotion regulation at both attentive (conscious) and subliminal (subconscious) processing levels, possibly via reducing *attentional capture* (as ascertained by the *EAB,* a highly sensitive measure of emotional attentional capacity) and/or reducing the activation of associative semantic networks by emotional stimuli (as ascertained by the *AP*), with trait *non-reactivity* and *equanimity* being the main mechanisms driving these effects.

The most important novel contribution of the present research to the understanding of the effects of meditation generally and mindfulness meditation in particular on attentional capacity, emotion regulation and sensory information processing is the role of trait *non-reactivity* and *equanimity* . Their relationships with the studied phenomena were present at both attentive (*Study 1)* and subliminal (*Study 3)* processing levels, driving more efficient and less affectively biased sensory information processing. This is evidenced by higher trait *non-reactivity* and *equanimity* in meditators being associated with: (i) lower *EAB*, possibly due to a reduced *attentional capture* by affective stimuli (*Study 1*); and (ii) weaker *AP* produced by incongruent primes during *AP* paradigm performance (*Study 3*), possibly via reduced (subliminal) *attentional capture* and/or associative semantic network activation. Further, the relationships of higher trait *non-reactivity* and *equanimity* with better performance on the employed paradigms were specific to the processing of affective information, since no such relationships were observed with *NAB* (*Study 1*) or *PPI* (*Study 2*) which involve attentional processing of 'neutral' sensory information. The findings suggested that trait *non-reactivity* and *equanimity* might be the main skills/processes acquired through meditation practice that underline the beneficial effects of meditation, particularly mindfulness as secularly defined, on *attentional capacity* and emotion regulation.

Findings provides tentative evidence that *EAB* paradigm performance is a potential candidate for being developed and used as an objective measure of meditation expertise, indexing *attentional capacity* and emotion regulation, with trait *non-reactivity* and *equanimity* as potential underlying mechanisms. If the associations of weaker *EAB* with higher trait *non-reactivity* and *equanimity* is confirmed in future research using cross-sectional and/or longitudinal design, the *EAB* paradigm performance could also be used as an objective measure of these traits as acquired through meditation practice, e.g. following MBIs. Kumari et al (2017) proposed the use of eye movement paradigms as potential objective measures of meditation training to assess attentional and cognitive control in meditators and non-meditators, since meditators demonstrated enhanced attentional control relative to non-meditators in their study. Following this approach, current findings provide a grounding for future studies to further develop the *EAB* paradigm as the objective measure of mindfulness training and expertise in cross-sectional and longitudinal studies. The current results could also explain the inconsistent findings in relation to the effects of meditation on *AB* reported in the literature since previous studies have not considered the roles of trait *non-reactivity* and *equanimity* in *AB* paradigm performance. Thus, future studies should consider the levels of trait *non-reactivity* and *equanimity,* both dispositional and trained*,* when using *AB* and particularly *EAB* paradigms in meditators or meditation-naïve individuals.

The findings of research reporting in this thesis also suggest that developing higher trait *non-reactivity* and *equanimity* should be targeted as important outcomes of MBIs as they might be skills/mechanisms that underly the beneficial effects of MBIs on cognitive processing, emotional balance, and overall well-being. Their possible role in reducing affective bias might drive the enhancing effects of MBIs specifically, and meditation training more generally, on stronger resilience and better adaptability in stressful situations and environments by lowering the intensity of emotional states and promoting more balanced, reflective responses. The focus on these traits might be particularly beneficial in the MBIs for clinical groups characterised by emotional dysregulation (e.g., anxiety disorders, depression) who demonstrate higher sensitivity towards negative information. Patients with depressive disorders were found to show strong negative priming effects (Yao et al., 2010) and slower processing of emotional prime stimuli (LeMoult et al., 2012), whereas anxiety levels were strongly associated with strength and direction of priming effects in depression and comorbid anxiety disorder (Dannlowski et al., 2006).

Overall, the results of the present research support positive effects of meditation on emotional regulation by reducing the impact of emotional stimuli with trait *non-reactivity* and *equanimity* as candidate underlying mechanisms. Other related and/or complementary processes/mechanisms might include *meta-awareness* (heightened awareness of one's thoughts and/or emotions without sudden reactivity or judgement, Lutz et al., 2008), *dereification* (Lutz et al., 2015) or *decentering* (Fresco et al., 2007) from thoughts and/or emotions by dis-identifying oneself with one's mental events as well as *cognitive defusion* (being less 'fused' or attached to one's own thoughts and/or emotions, Masuda et al., 2004). Future studies should investigate the inter-relationships of these constructs with *non-reactivity* and *equanimity*, and assess their role in *AB*, *PPI*, and *AP* phenomena.

There were no differences in *PPI* effects between meditators and non-meditators; however, this finding is in line with previous studies (Åsli et al., 2021; Kumari et al., 2015) and a recent study by Kumari et al. (2024) which had included as sub-sample of *Study 2* participants. Associations of higher *PPI* with slower RTs for correctly identified T2 stimuli in the *NAB* paradigm as well as of *PPI* and *EAB* magnitudes in non-meditators, provided evidence of potentially shared or similar underlying mechanisms between *PPI* and *AB* phenomena deserving further investigation in meditators and meditation-naïve individuals. Overall, findings might have implications for the development of the MBIs targeting inhibitory deficits observed in clinical disorders (e.g. schizophrenia, attention-deficit hyperactivity disorder).

Findings across three studies provided tentative evidence of differential effects of meditation in males and females on enhancing *attentional capacity* and emotion regulation during the processing of emotionally salient information, possibly via reduced *attentional capture* by emotionally salient stimuli, as indexed by no impact of emotional T1 targets on *EAB* in female meditators on trials with the most *AB*-inducing interval (lag 200 ms) in *Study 1* and faster identification of T2 targets following both emotional and neutral T1 *EAB* targets in male meditators, relative to non-meditators in *Study 2*. Female non-meditators were also impacted by emotional stimuli during *AP* paradigm performance whereas female meditators were not

(*Study 3*). Sex differences might thus play an important role in the effect of meditation on emotional processing, with meditation potentially being more beneficial in enhancing emotion regulation in females at both conscious and subliminal information processing levels. These findings warrant further investigation into potential sex differences of meditation training on emotion regulation.

8.3 Methodological Limitations and Future Research Directions

The methodological limitations for each empirical study of the thesis are discussed separately in previous thesis chapters; here the overall limitations of the approach taken in this thesis are highlighted.

One of the general limitations is related to using years of practice as one of the criteria for recruiting meditators. Meditation practice quantity as indexed by the years (or hours) of practice does not necessitate practice quality, particularly in meditators of intermediate expertise, with the meditators with similar practice duration potentially being at different stages of practice attainment (e.g. *process* vs *'result',* Chapter 1, Section 1.1.5). Furthermore, individuals practicing within the context of MBSR/MBCT might not achieve the same levels of 'depth' in their conceptual and experiential understanding of mindfulness as meditators practicing within different Buddhist traditions. To eliminate the ambiguity of practitioners being at different stages of practice, future studies should assess meditators' expertise by using objective measures such as the *AB* paradigm or eye-movement paradigms (Kumari et al., 2017).

Another general limitation is related to the meditation grouping into mindfulness as secularly defined (MaSD) vs other meditation traditions (OMT). The MaSD group included practices from the *attentional* (OM) and *deconstructive* (Dzogchen and Mahamudra, Zen) families (Dahl et al., 2015), which are relatively homogeneous in terms of the practice approach and underlying mechanisms, making it possible to predict the direction of meditation effect on *AB* based on previous research and yielding significant correlations of *NAB* and *EAB* magnitudes with the levels of train *non-reactivity* and *equanimity*. The rationale for combining these *attentional* and *deconstructive* practice types into the MaSD subgroup mainly rested on the proposed similarities between approach to meditation as practiced in MBSR/MBCT and Dzogchen and Mahamudra approaches of Tibetan Buddhism (Antonova et al 2021; Dunne, 2011), characterised by the same 'effortless' approach to meditation (Dunne, 2011). The grouping was also driven by the pragmatic approach due to the opportunistic recruitment of meditators for *Studies 1* and *3*, which did not allow for the use of typology proposed by Dahl and colleagues (2015). However, the OMT subgroup, which included *attentive* (FA), *constructive,* and *deconstructive* (other than included in the MaSD) was much more heterogeneous in terms of practice approach and underlying mechanisms. This heterogeneity might have obscured potential differential effects of meditation approaches included in the OMT subgroup on either enhancing or reducing *AB* (Chapter 3, Section 3.2) and/or ability to detect the associations of *NAB/EAB* magnitudes with trait *non-reactivity* and *equanimity* due to the potential differential effects of these meditation approaches on these traits. Future studies should use targeted recruitment to disentangle the differential effects of meditational families proposed by Dahl et al (2015), since their effects are underlined by different cognitive and affective mechanisms. It is important to note that for 'expert' meditators, meditation practice style might not be crucial, but for the 'beginners' or the meditation practitioners of 'intermediate expertise' different meditation practice styles/families would impact cognitive and attentional processing (e.g. top-down vs bottom-up attentional processing) differentially. Close attention should also be paid when investigating the effects of FA practices (sustaining selective attention) vs OM practices (more open aperture of attention without a particular focus) (Lutz et al., 2015), as these could result in different effects on attentional processing during *AB* paradigm performance (Chapter 1, Section 1.1.5; Chapter 3, Section 3.2).

A third limitation is the use of self-report measures to assess trait *mindfulness* and *equanimity,* which can introduce subjective bias in the data (due to the item interpretation and/or inaccurate self-assessment). Nevertheless, validated scales of trait *mindfulness* (FFMQ) and *equanimity* (NAS-7) were employed which showed good Cronbach's α values (.72 - .84) across the empirical studies and are considered to be the most widely used self-report measures to assess these traits (Chapter 2, Section 2.1). Moreover, meaningful associations, and in predicted directions, were observed of *EAB* and *AP* with trait *non-reactivity* and *equanimity*. Nevertheless, future studies should include both subjective and objective measures of trait *mindfulness* and *equanimity* when studying their roles in the effects of meditation on attentional capacity and emotion regulation. Given the current thesis findings, a promising future direction would be to develop the use of *EAB* and *AP* paradigms as potential objective markers of higher trait *equanimity* and *non-reactivity* in meditators in cross-sectional studies as well as the objective measures of these traits as MBIs' outcomes (Section 8.3 for more details).

A fourth limitation is related to the sampling method. The participant recruitment for the samples of *Studies 1* and *3* took place via opportunistic sampling, with meditation experience of participants recruited via the TestableMinds taken at face value. Although the recruitment of the meditators for Study 2 was targeted, with as much adherence to the meditation experience criteria and practice type (mindfulness as secularly defined) as possible, recruiting the meditators' sample size within the time-constrains was extremely difficult. Since the time window for *Study 2* recruitment was immediately following the COVID-19 pandemic, meditators might have been hesitant to participate in a lab-based experiment. Furthermore, due to a targeted approach and stricter adherence to the mediation experience criteria in *Study 2*, which resulted in a group of meditators who were older on average as compared with *Studies 1* & *3*, the findings of *Study 2* might not be immediately comparable to those of *Studies 1* and *3*.

A final limitation is that all empirical studies were conducted using a cross-sectional study design, which does not allow differentiating between the possible pre-existing differences in the levels of dispositional vs trained trait *non-reactivity* and *equanimity* between meditators and non-meditators. Thus, any differences between meditators and non-meditators on the performance of employed paradigms, including the differential sex effects, might be potentially explained by the differences present prior to meditators starting meditation practice. Future research should use longitudinal study design to investigate the effects of meditation on *AB* and *AP* in order to further develop them as objective measures of meditation expertise.

An additional future research direction is to investigate the effects of meditation practice on the *EAB* paradigms by studying underlying neural correlates using functional Magnetic Resonance Imaging (fMRI). Key neural areas associated with *attentional capture* include the anterior insula, medial precentral regions, sensorimotor areas and supplementary motor cortex (Marxen et al., 2021). However, to date, no study has reported the neural correlates of emotional *attentional capture* in mindfulness meditators using an *EAB* paradigm. The *NAB* paradigm designed for the empirical studies reported here contained red-coloured digits as targets which could have been perceived as 'more salient'; future studies using both behavioural and fMRI methods should use colour-neutral *NAB* target stimuli. Further, *attentional capture* as measured in the lab might not accurately represent 'real-time' *attentional capture* since the magnitude of initial *attentional capture* in real-time is higher than the one induced in-lab conditions and also does not contain multiple distractors (Adam et al., 2024).

Future research should take note as this can have implications when investigating the effects of meditation on *attentional capture/capacity*. Future studies should also be sufficiently powered and balanced to examine sex differences in meditation studies.

Attention modulates eyeblink timings and temporal patterns, with research showing that eyeblink rate is more suppressed with higher paradigm difficulty levels (i.e. higher attentional demands) (Oh et al., 2012). Such eyeblink suppression could therefore be associated with the *AB* paradigm performance, and henceforth measuring the eyeblink rate and timings might be useful when studying *AB* phenomenon Indeed, the *AB* effect has been shown to vary with standard blink rate since a reduced blink rate and blink suppression is linked with stronger attentional engagement during information processing (Martins et al., 2015; Maffei et al., 2019), i.e. 10-25 blinks per minute at rest vs <5 blinks per minute when attentional resources are engaged (Bentivoglio, 1997) as well as alterations in eyeblink pattern. Blink suppression is essential in ensuring minimal loss of information during attentional processing. Since blink rate is also impacted by emotional valence (i.e. stronger and early blink suppression for compassion vs slower and later blink suppression for sad stimuli) (Maffei et al., 2019), it could modulate *EAB* effects, depending on emotional valence of T1 stimuli. Recording eyeblink timings in *AB*-related research will also help to more accurately quantify cognitive *AB* (i.e. inattentive blindness due to the attention being captured by T1) by differentiating the trials with no spontaneous eyeblink from the trials where T2 stimuli were missed due to a spontaneously occurring eyeblink. Future studies should, therefore, use the EOG recording during *AB* paradigm performance to ensure more accurate *AB* magnitude quantification during *NAB/EAB* paradigm performance. EOG could also advance understanding about the neurophysiological correlates of the *AB* (i.e. eyeblink timings and rates could be associated with changes in neural activity underlying attentional demand (Sciarraffa et al., 2021). Furthermore, measuring eye-movements during *AB* paradigm performance can be potentially used to objectively index sustained attention (in addition to, or instead of, T1/T2 recollection) by analysing how attention might shift away and refocus on stimuli based on eye movement patterns during the *AB* paradigm performance, enabling a more nuanced and accurate understanding of attentional allocation during the *AB* paradigm performance (Ophir et al., 2020). Eye-movements might also be used as a psychophysiological proxy of *attentional capture* during *AB* paradigm performance by quantifying fixation durations and saccade rates, e.g. longer T1 fixation and shorter T2 fixation could indicate attentional capture by T1, resulting in *AB* to T2.

8.4 Conclusion

The findings of this thesis highlight the important role of trait *non-reactivity* and *equanimity* as mechanisms underlying the enhancing effects of meditation on attentional capacity and emotion regulation during sensory information processing, possibly via reducing *attentional capture* and/or activation of associative semantic networks by affective stimuli at both attentive and subliminal processing levels. The findings also confirm the expected effect of meditation on reducing affective biases during sensory information processing as evidenced by the lack of priming effects by affective stimuli of different valence in meditators. Together, these findings further strengthen the evidence-base for the beneficial effects of meditation on attentional capacity and emotional processing/regulation reported in previous research. Elucidating the mechanisms underlying the beneficial effects of meditation on cognitive and affective processing is important for developing more effective MBIs for the treatment of the psychological disorders characterised by emotion dysregulation as well as for the enhancement of mental health and well-being in healthy individuals. Future research should employ longitudinal designs to study the effects of meditation on *AB* and *AP* in order to develop them as objective measures of meditation practice expertise for the use in intervention studies as well as more generally in research investigating the effects of meditation on cognition and emotion.

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Appendix A. Chapter 5 (Study 1) Supplementary Materials

Figure A1. Meditation History Questionnaire (MHQ)

Meditation History Questionnaire

1. Do you practice sitting meditation, contemplation, or a body-centred awareness practice (e.g. yoga, qigong, tai chi, etc.)?

2. How regularly do you practice **sitting meditation**?
   - I do not practice sitting meditation
   - occasionally
   - sometimes regularly, sometimes occasionally
   - regularly

3. How long have you been practicing **sitting meditation regularly** (at least once a week, excluding any breaks of longer than 6 months)?
   - Years
   - months

4. What is your regular **sitting meditation** practice routine?
   - number of days a week
   - number of times a day
   - average practice session duration (minutes)

5. How did you first learn to meditate?
   - DIY (do it yourself, e.g. with a help of a book, a friend, etc.)
   - Instructed by a qualified teacher in a traditional setting (e.g. Buddhist centre, retreat, etc.)
   - Smartphone app/online resource/guided mp3 recordings
   - Mindfulness-based Stress Reduction (MBSR) or Mindfulness-based Cognitive Therapy (MBCT) face-to-face course
   - MBSR or MBCT online course
   - Other (please specify)

6. Which tradition of **sitting meditation** (or contemplation) do you follow **most consistently**?
   - Secular mindfulness (MBSR, MBCT, other secular mindfulness approaches)
   - Buddhist: Vipassana/Insight (Theravada)
   - Buddhist: Vajrayana (Tibetian)
   - Buddhist: Dzogchen/Mahamudra (Tibetan)
   - Buddhist: Zen
   - Advaita Vedanta
   - Transcendental meditation
   - Yoga Sutra
   - Agni Yoga
   - Christian meditation/contemplation
   - Sufi meditation: Zikr/ Muraqabah/ Whirling
   - Islamic meditation: Zikr/ Salah
   - Jain

   Other (please specify)

7. Which other traditions of **sitting meditation** (or contemplation) are you familiar with and may practice **occasionally**? (please tick all that apply)

- Secular mindfulness (MBSR, MBCT, other secular mindfulness approaches)
- Buddhism: Vipassana/Insight (Theravada)
- Buddhist: Vajrayana (Tibetian)
- Buddhist: Dzogchen/Mahamudra (Tibetan)
- Buddhism: Zen
- Advaita Vedanta
- Transcendental meditation
- Yoga Sutra
- Agni Yoga
- Christian meditation/contemplation
- Sufi meditation: Zikr/ Muraqabah/ Whirling
- Islamic meditation: Zikr/ Salah
- Jain
- Other (please specify)
- Neither

8. What is your **main regular sitting meditation** practice?
- Mindfulness of the breath and/or body (e.g. MBSR/MBCT, other secular approaches)
- Mindfulness of thoughts and feelings (e.g. MBSR/MBCT, other secular approaches)
- Choiceless/Open awareness (e.g. MBSR/MBCT, other secular approaches)
- Concentration (e.g. Theravada: Jhana practice)
- Calm abiding (Samatha) with an object/support (e.g. breath, candle,etc.)
- Calm abiding (Samatha/Vipassana) without an object/support
- Vipassana (Insight) with analytical enquiry
- Resting in the nature of mind/Open presence (e.g. Tibetan)
- Just sitting (e.g. Zen: Shikantaza)
- Loving-kindness (metta)
- Compassion (non-referential)
- Diety Visualisation (e.g. Tibetan: Yidam practice)
- Guru Yoga (e.g. Tibetan)
- Mantra recitation
- Visualisation/journeying
- Inner (subtle body) yoga (e.g. working with chakras, channels/nadis, chi/lung/kundalini energy, etc.)
- Yoga Nidra
- Sri Sri Ravishankar's Art of living Meditations
- Sadhguru's Isha Kriya guided Meditation
- Brahma Kumari's Rajayoga Meditation (BKRYM)
- Other (please specify)

9. What other **sitting meditation** practices do you engage in, **either regularly or occasionally**? (please tick all that apply)
- Mindfulness of the breath and/or body (e.g. MBSR/MBCT, other secular approaches)
- Mindfulness of thoughts and feelings (e.g. MBSR/MBCT, other secular approaches)
- Choiceless/Open awareness (e.g. MBSR/MBCT, other secular approaches)
- Concentration (e.g. Theravada: Jhana practice)
- Calm abiding (Samatha) with an object/support (e.g. breath, candle,etc.)

- Calm abiding (Samatha/Vipassana) without an object/support
- Vipassana (Insight) with analytical enquiry
  Resting in the nature of mind/Open presence (e.g. Tibetan)
- Just sitting (e.g. Zen: Shikantaza)
- Loving-kindness (metta)
- Compassion (non-referential)
- Diety Visualisation (e.g. Tibetan: Yidam practice)
- Guru Yoga (e.g. Tibetan)
- Mantra recitation
- Visualisation/journeying
- Inner (subtle body) yoga (e.g. working with chakras, channels/nadis, chi/lung/kundalini energy, etc.)
- Yoga Nidra
- Sri Sri Ravishankar's Art of living Meditations
- Sadhguru's Isha Kriya guided Meditation
- Brahma Kumari's Rajayoga Meditation (BKRYM)
- Other (please specify)
- Neither

10. How do you usually meditate in your regular setting?
- Alone, no guidance
- In a group, with guidance of a teacher/instructor
- Alone, with guidance (e.g. an mp3, app, etc.)
- In a group, with guidance of an mp3, app, etc.
- In a group, no or minimal guidance
- Other (please specify more than one if relevant)

11. How many **sitting meditation retreats with a qualified teacher/instructor** have you done in total? (please enter '0' for the options that do not apply)
- 3-day
- 5-day
- 10-day
- 3-month
- 3-year

Other (please specify the duration with the number in brackets (e.g. '1-month (3)' for 1-month retreat 3 times)

12. How many **sitting meditation self-retreats** have you done in total?
- total number of self-retreats
- average duration of self-retreats (in days)

13. Do you practice **mindfulness in daily activities**?
- Never
- Almost never
- Some of the time
- Most of the time
- Almost always
- Always

14. How **regularly** do you engage in **movement** or **body-centred awareness** practice?

○ I do not engage in movement/body-centred awareness practices ○ Occasionally ○ sometimes regularly, sometimes occasionally ○ regularly
15. What is your regular **movement or body-centered awareness** practice routine? ○ number of days a week ○ number of times a day average practice session duration (minutes)
16. How long have you been engaging in **movement or body-centered awareness practice regularly?** ○ Years ○ Months
17. Which **movement or body-centred awareness practices** do you engage with **regularly**? ○ Body scan (lying down, e.g. MBSR/MBCT) ○ Mindful movement (e.g. MBSR/MBCT) ○ Yoga ○ Qigong ○ Tai chi ○ Tsa lung ○ Forest bathing ○ Asana ○ Pranayama ○ Other (please specify)
18. Which **movement or body-centred awareness practices** do you engage with **occasionally (please tick all that apply)**? ○ Body scan (lying down, e.g. MBSR/MBCT) ○ Mindful movement (e.g. MBSR/MBCT) ○ Yoga ○ Qigong ○ Tai chi ○ Tsa lung ○ Forest bathing ○ Asana ○ Pranayama ○ Other (please specify)

Table A1. Mean (SD) Reaction Time for T1 and T2 target position during *Neutral Attentional Blink (NAB)* paradigm at lags 200 ms, 300 ms, 400 ms, 500 ms, and 700 ms for Non-meditator group Meditator group/subgroups (GroupMT: Mindfulness as Secularly Defined (MaSD) vs Other Meditation Traditions (OMT), as well as the inferential statistics for the results of 2 (Target Position: T1, T2) x 5 (Lag: 200 ms, 300 ms, 400 ms, 500 ms, 700 ms) x 2 (Group: Meditator, Non-meditator)/3 (GroupMT: MaSD, OMT, Non-meditator) x 2 (Sex: Male, Female) repeated-measures ANOVAs.

NAB	Lag (ms)	Target Position	Non-meditators (N = 54) Mean (SD)	Meditators (N = 75) Mean (SD)	MaSD (N = 45) Mean (SD)	OMT (N = 30) Mean (SD)
T1 Neutral/ T2 Neutral	200	T1	1.14 (.32)	1.35 (1.40)	1.16 (.34)	1.64 (2.16)
		T2	.51 (.30)	.50 (.34)	.43 (.20)	.60 (.46)
	300	T1	1.05 (.33)	1.24 (1.06)	1.15 (.51)	1.38 (1.57)
		T2	.48 (.32)	.45 (.28)	.41 (.17)	.52 (.39)
	400	T1	1.05 (.35)	1.09 (.46)	1.03 (.28)	1.17 (.63)
		T2	.48 (.23)	.51 (.51)	.43 (.17)	.64 (.77)
	500	T1	1.01 (.36)	1.10 (.79)	1.01 (.32)	1.23 (1.18)
		T2	.50 (.32)	.47 (.25)	.43 (.18)	.52 (.33)
	700	T1	.99 (.31)	1.04 (.61)	.99 (.28)	1.13 (.90)
		T2	.50 (.29)	.46 (.23)	.43 (.21)	.51 (.25)

Non-meditator vs Meditator Groups

Within-subject main effects:
Target Position: $F_{1, 125} = 183.4$, $\boldsymbol{p < .001}$, $\eta_p^2 = .60$

Lag: $F_{1.7, 211.1} = 9.26$, $\boldsymbol{p < .001}$, $\eta_p^2 = .07$

Between-subject main effects:
Group: $F_{1, 125} = .53$, $p = .47$, $\eta_p^2 = .004$

Sex: $F_{1, 125} = .19$, $p = .67$, $\eta_p^2 = .002$

Interactions:
Target Position x Group: $F_{1, 125} = 1.22$, $p = .27$, $\eta_p^2 = .01$
Target Position x Group x Sex: $F_{1, 125} = 1.24$, $p = .27$, $\eta_p^2 = .01$

Lag x Group: $F_{1.7, 211.1} = .1.42$, $p = .25$, $\eta_p^2 = .011$
Lag x Group x Sex: $F_{1.7, 211.1} = .13$, $p = .84$, $\eta_p^2 = .001$

Target Position x Lag: $F_{1.4, 178.8} = 4.68$, $\boldsymbol{p = .02}$, $\eta_p^2 = .04$
Target Position x Lag x Group: $F_{1.4, 178.8} = 1.15$, $p = .30$, $\eta_p^2 = .009$
Target Position x Lag x Group x Sex: $F_{1.4, 178.8} = .46$, $p = .57$, $\eta_p^2 = .004$

Group x Sex: $F_{1, 125} = .16$, $p = .69$, $\eta_p^2 = .001$

Non-meditator vs MaSD vs OMT Groups

Within-subject main effects:
Target Position: $F_{1, 123} = 200.1$, $\boldsymbol{p < .001}$, $\eta_p^2 = .62$

Lag: $F_{1.7, 208.2} = 14.18$, $\boldsymbol{p < .001}$, $\eta_p^2 = .10$

Between-subject main effects:
GroupMT: $F_{2, 123} = 1.45$, $p = .24$, $\eta_p^2 = .02$

Sex: $F_{1, 123} = .22$, $p = .64$, $\eta_p^2 = .002$

Interactions:
Target Position x GroupMT: $F_{2, 123} = .88$, $p = .42$, $\eta_p^2 = .01$
Target Position x GroupMT x Sex: $F_{2, 123} = 1.80$, $p = .17$, $\eta_p^2 = .03$

Lag x GroupMT: $F_{3.4, 208.2} = 2.34$, $p = .07$, $\eta_p^2 = .04$
Lag x GroupMT x Sex: $F_{3.4, 208.2} = .62$, $p = .62$, $\eta_p^2 = .01$

Target Position x Lag: $F_{1.4, 176.3} = 7.09$, $\boldsymbol{p = .003}$, $\eta_p^2 = .05$
Target Position x Lag x GroupMT: $F_{2.9, 176.3} = 1.28$, $p = .28$, $\eta_p^2 = .02$
Target Position x Lag x GroupMT x Sex: $F_{2.9, 176.3} = 1.25$, $p = .29$, $\eta_p^2 = .02$

GroupMT x Sex: $F_{2, 123} = .29$, $p = .75$, $\eta_p^2 = .005$

Table A2. Mean (SD) Reaction Time for T1 and T2 target position during *Emotional Attentional Blink (EAB)* paradigm at lags 200 ms, 300 ms, 500 ms, and 700 ms for Non-meditator group and Meditator group/subgroups (GroupMT: Mindfulness as Secularly Defined (MaSD) vs Other Meditation Traditions (OMT)), as well as the inferential statistics for the results of 2 (Target Position: T1, T2) x 2 (Condition: Neutral, Emotional) x 4 (Lag: 200 ms, 300 ms, 500 ms, 700 ms) x 2 (Group: Non-meditator, Meditator)/3 (Non-meditator, GroupMT: MaSD, OMT) x 2 (Sex: Male, Female) repeated-measures ANOVAs.

EAB	Lag (ms)	Target Position	Non-meditators (N = 54) Mean (SD)	Meditators (N = 75) Mean (SD)	MaSD (N = 45) Mean (SD)	OMT (N = 30) Mean (SD)
T1 Neutral /T2 Neutral	200	T1	1.44 (.55)	1.38 (.48)	1.38 (.53)	1.39 (.40)
		T2	1.75 (.79)	1.81 (.93)	1.70 (.59)	1.97 (1.27)
	300	T1	1.46 (.71)	1.36 (.53)	1.39 (.61)	1.31 (.38)
		T2	1.46 (.65)	1.65 (1.11)	1.77 (1.32)	1.47 (.67)
	500	T1	1.34 (.48)	1.29 (.45)	1.28 (.51)	1.30 (.35)
		T2	1.37 (.59)	1.39 (.78)	1.41 (.81)	1.36 (.74)
	700	T1	1.53 (.58)	1.43 (.51)	1.43 (.58)	1.44 (.40)
		T2	1.36 (.58)	1.36 (.72)	1.38 (.85)	1.34 (.48)
T1 Emotional /T2 Neutral	200	T1	1.40 (.51)	1.41 (.55)	1.35 (.53)	1.50 (.59)
		T2	1.79 (.85)	1.73 (.70)	1.77 (.70)	1.65 (.70)
	300	T1	1.35 (.45)	1.36 (.57)	1.41 (.69)	1.30 (.34)
		T2	1.76 (1.68)	1.58 (.68)	1.62 (.72)	1.53 (.62)
	500	T1	1.34 (.51)	1.29 (.45)	1.26 (.49)	1.33 (.39)
		T2	1.38 (.49)	1.52 (1.02)	1.63 (1.25)	1.36 (.46)
	700	T1	1.40 (.56)	1.34 (.70)	1.37 (.85)	1.29 (.37)
		T2	1.31 (.48)	1.34 (.73)	1.33 (.64)	1.35 (.86)

Non-meditator vs Meditator Groups

__Within-subject main effects:__
Target Position: $F_{1, 118} = 16.5$, ***p* <.001**, $\eta_p^2 = .12$

Condition: $F_{1, 118} = .13$, $p = .72$, $\eta_p^2 = .001$

Lag: $F_{2.6, 302.3} = 15.6$, ***p* <.001**, $\eta_p^2 = .12$

__Between-subject main effects:__
Group: $F_{1, 118} = .38$, $p = .54$, $\eta_p^2 = .003$

Sex: $F_{1, 118} = .31$, $p = .58$, $\eta_p^2 = .003$

__Interactions:__
Target Position x Group: $F_{1, 118} = 2.30$, $p = .13$, $\eta_p^2 = .02$
Target Position x Group x Sex: $F_{1, 118} = .87$, $p = .35$, $\eta_p^2 = .007$

Condition x Group: $F_{1, 118} = .04$, $p = .84$, $\eta_p^2 = .000$
Condition x Group x Sex: $F_{1, 118} = .07$, $p = .79$, $\eta_p^2 = .001$

Lag x Group: $F_{2.6, 302.3} = .13$, $p = .92$, $\eta_p^2 = .001$
Lag x Group x Sex: $F_{2.6, 302.3} = .54$, $p = .63$, $\eta_p^2 = .005$

Target Position x Condition: $F_{1, 118} = 2.69$, $p = .10$, $\eta_p^2 = .02$
Target Position x Condition x Group: $F_{1, 118} = 2.04$, $p = .16$, $\eta_p^2 = .02$
Target Position x Condition x Group x Sex: $F_{1, 118} = .19$, $p = .66$, $\eta_p^2 = .002$

Target Position x Lag: $F_{2.5, 292.4} = 12.73$, ***p* <.001**, $\eta_p^2 = .10$
Target Position x Lag x Group: $F_{2.5, 292.4} = .27$, $p = .81$, $\eta_p^2 = .002$
Target Position x Lag x Group x Sex: $F_{2.5, 292.4} = 1.41$, $p = .24$, $\eta_p^2 = .01$

		Condition x Lag: $F_{2.7, 319.3} = .95$, $p = .41$, $\eta_p^2 = .008$ **Condition x Lag x Group:** $F_{2.7, 319.3} = .78$, $p = .49$, $\eta_p^2 = .007$ **Condition x Lag x Group x Sex:** $F_{2.7, 319.3} = .86$, $p = .45$, $\eta_p^2 = .007$ **Target Position x Condition x Lag:** $F_{2.6, 311.3} = .31$, $p = .80$, $\eta_p^2 = .003$ **Target Position x Condition x Lag x Group:** $F_{2.6, 311.3} = 1.52$, $p = .21$, $\eta_p^2 = .01$ **Target Position x Condition x Lag x Group x Sex:** $F_{2.6, 311.3} = .77$, $p = .50$, $\eta_p^2 = .006$ **Group x Sex:** $F_{1, 118} = 4.93$, $p = .03$, $\eta_p^2 = .04$
Non-meditator vs MaSD vs OMT Groups	**<u>Within-subject main effects:</u>** **Target Position:** $F_{1, 116} = 19.9$, **$p < .001$**, $\eta_p^2 = .15$ **Condition:** $F_{1, 116} = .28$, $p = .60$, $\eta_p^2 = .002$ **Lag:** $F_{2.6, 298.3} = 16.6$, **$p < .001$**, $\eta_p^2 = .13$ **<u>Between-subject main effects:</u>** **GroupMT:** $F_{2, 116} = .30$, $p = .74$, $\eta_p^2 = .005$ **Sex:** $F_{1, 116} = .01$, $p = .91$, $\eta_p^2 = .00$	**<u>Interactions:</u>** **Target Position x GroupMT:** $F_{2, 116} = 1.59$, $p = .21$, $\eta_p^2 = .03$ **Target Position x GroupMT x Sex:** $F_{2, 116} = .67$, $p = .51$, $\eta_p^2 = .01$ **Condition x GroupMT:** $F_{2, 116} = .08$, $p = .93$, $\eta_p^2 = .001$ **Condition x GroupMT x Sex:** $F_{2, 116} = 1.02$, $p = .36$, $\eta_p^2 = .02$ **Lag x GroupMT:** $F_{5.1, 298.3} = .98$, $p = .44$, $\eta_p^2 = .02$ **Lag x GroupMT x Sex:** $F_{5.1, 298.3} = .32$, $p = .91$, $\eta_p^2 = .005$ **Target Position x Condition:** $F_{1, 116} = 1.02$, $p = .31$, $\eta_p^2 = .009$ **Target Position x Condition x GroupMT:** $F_{2, 116} = 1.41$, $p = .25$, $\eta_p^2 = .02$ **Target Position x Condition x GroupMT x Sex:** $F_{2, 116} = .16$, $p = .85$, $\eta_p^2 = .003$ **Target Position x Lag:** $F_{2.5, 285.8} = 12.05$, **$p < .001$**, $\eta_p^2 = .09$ **Target Position x Lag x GroupMT:** $F_{4.9, 285.8} = .43$, $p = .82$, $\eta_p^2 = .007$ **Target Position x Lag x GroupMT x Sex:** $F_{4.9, 285.8} = .86$, $p = .51$, $\eta_p^2 = .02$ **Condition x Lag:** $F_{2.7, 316.3} = .92$, $p = .43$, $\eta_p^2 = .008$ **Condition x Lag x GroupMT:** $F_{5.5, 316.3} = .68$, $p = .66$, $\eta_p^2 = .01$ **Condition x Lag x GroupMT x Sex:** $F_{5.5, 316.3} = .79$, $p = .57$, $\eta_p^2 = .01$ **Target Position x Condition x Lag:** $F_{2.6, 306.9} = .59$, $p = .60$, $\eta_p^2 = .005$ **Target Position x Condition x Lag x GroupMT:** $F_{5.3, 306.9} = 2.17$, **$p = .05$**, $\eta_p^2 = .04$ **Target Position x Condition x Lag x GroupMT x Sex:** $F_{5.3, 306.9} = .67$, $p = .65$, $\eta_p^2 = .01$ **GroupMT x Sex:** $F_{2, 116} = 2.61$, $p = .08$, $\eta_p^2 = .04$

Table A3. Spearman's Rho correlation coefficients for the relationships of *Neutral Attentional Blink (%NAB)* and *Emotional Attentional Blink (%EAB) magnitude* with trait *mindfulness* (FFMQ) and *equanimity* (NAS-7) in the whole sample, Non-meditator group and Meditator group/subgroups (Mindfulness as Securely Defined (MaSD) and Other Meditation Traditions (OMT).

			Self-Report Measures, *r* (*p*)						
***AB* Paradigm**	**Lag (ms)**		**NAS-7 *Equanimity***	**FFMQ Observing**	**FFMQ Describing**	**FFMQ Acting with Awareness**	**FFMQ Non-judging**	**FFMQ *Non-reactivity***	**FFMQ Total**
% NAB	200								
		Whole sample	-.10 (.26)	.02 (.86)	.06 (.49)	-.06 (.53)	-.05 (.55)	-.11 (.23)	-.04 (.67)
		Non-meditators	.04 (.78)	.17 (.23)	.11 (.43)	-.13 (.35)	-.09 (.51)	.05 (.74)	-.03 (.86)
		Meditators	-.18 (.12)	-.05 (.70)	.01 (.96)	-.02 (.88)	-.06 (.63)	-.21 (.07)	-.04 (.72)
		MaSD	-.12 (.44)	.04 (.80)	-.01 (.96)	.02 (.90)	-.07 (.65)	-.20 (.20)	-.07 (.67)
		OMT	-.15 (.43)	-.14 (.48)	.20 (.28)	.02 (.90)	.19 (.31)	-.15 (.42)	.21 (.27)
	300								
		Whole sample	.01 (.96)	.02 (.85)	.06 (.48)	-.01 (.87)	.00 (.99)	-.05 (.59)	.002 (.98)
		Non-meditators	.15 (.30)	**.28 (.04)**	.20 (.16)	-.08 (.57)	-.11 (.44)	.17 (.21)	.03 (.82)
		Meditators	-.08 (.49)	-.14 (.23)	-.06 (.64)	.04 (.74)	.08 (.52)	-.20 (.09)	.001 (1.0)
		MaSD	-.05 (.76)	-.04 (.77)	-.19 (.22)	-.08 (.62)	-.01 (.96)	-.17 (.28)	-.15 (.32)
		OMT	-.10 (.62)	-.26 (.16)	.28 (.13)	.23 (.23)	**.36 (.05)**	-.21 (.26)	.34 (.07)
	400								
		Whole sample	-.05 (.57)	.05 (.58)	.10 (.27)	-.01 (.95)	.00 (.97)	-.01 (.93)	.05 (.61)
		Non-meditators	.06 (.69)	.14 (.31)	.24 (.09)	-.08 (.56)	-.11 (.42)	.12 (.38)	.03 (.82)
		Meditators	-.11 (.37)	.00 (.99)	.00 (.99)	.06 (.64)	.08 (.49)	-.09 (.45)	.07 (.57)
		MaSD	-.02 (.88)	.05 (.76)	.00 (.99)	-.08 (.62)	.02 (.88)	-.04 (.81)	.009 (.95)
		OMT	-.15 (.43)	-.04 (.85)	.13 (.49)	.24 (.20)	.35 (.06)	-.09 (.64)	.25 (.19)
	500								
		Whole sample	-.06 (.53)	.03 (.73)	.08 (.36)	.01 (.94)	-.02 (.81)	-.15 (.09)	-.004 (.96)
		Non-meditators	.02 (.92)	.24 (.08)	.19 (.18)	-.15 (.29)	-.22 (.11)	.08 (.55)	-.04 (.79)
		Meditators	-.05 (.64)	-.04 (.71)	.04 (.77)	.13 (.26)	.09 (.42)	**-.29 (.01)**	.06 (.64)
		MaSD	-.20 (.18)	.04 (.81)	-.12 (.43)	-.07 (.66)	-.14 (.36)	-.24 (.12)	-.17 (.25)
		OMT	.21 (.27)	-.20 (.29)	**.37 (.05)**	**.41 (.03)**	**.55 (.002)**	-.34 (.07)	**.44 (.02)**
	700								
		Whole sample	-.10 (.25)	.14 (.10)	.01 (.87)	-.05 (.56)	-.07 (.45)	-.03 (.74)	-.03 (.73)
		Non-meditators	-.15 (.29)	.26 (.06)	.03 (.82)	-.21 (.14)	-.26 (.06)	.05 (.71)	-.13 (.36)
		Meditators	-.06 (.61)	.10 (.42)	.02 (.84)	.08 (.49)	.05 (.68)	-.08 (.48)	.07 (.56)
		MaSD	-.03 (.86)	.13 (.41)	-.03 (.83)	.09 (.56)	.09 (.58)	-.09 (.55)	.06 (.71)
		OMT	-.14 (.46)	.04 (.83)	.05 (.79)	.01 (.95)	-.10 (.61)	-.07 (.72)	-.03 (.88)

	200								
		Whole sample	-.10 (.24)	.05 (.58)	**.17 (.05)**	-.04 (.68)	.004 (.96)	-.05 (.54)	.07 (.43)
		Non-meditators	-.03 (.82)	.13 (.36)	.23 (.09)	.07 (.61)	-.06 (.65)	-.11 (.43)	.09 (.54)
		Meditators	-.11 (.33)	.04 (.72)	.17 (.13)	-.10 (.39)	.07 (.57)	-.01 (.93)	.10 (.41)
		MaSD	-.14 (.35)	.08 (.61)	.18 (.23)	-.25 (.09)	.03 (.86)	-.14 (.36)	-.002 (.99)
		OMT	-.09 (.63)	-.03 (.89)	.10 (.60)	.03 (.88)	.02 (.94)	.21 (.26)	.13 (.50)
	300								
		Whole sample	-.12 (.17)	.04 (.66)	.11 (.23)	-.002 (.99)	-.12 (.18)	-.08 (.35)	-.03 (.78)
		Non-meditators	-.04 (.77)	.15 (.28)	.27 (.05)	.07 (.62)	-.16 (.24)	-.11 (.43)	.03 (.81)
		Meditators	-.17 (.14)	-.02 (.84)	-.02 (.90)	-.07 (.58)	-.09 (.44)	-.11 (.33)	-.06 (.61)
		MaSD	-.19 (.21)	.01 (.94)	-.09 (.55)	**-.35 (.02)**	-.15 (.34)	-.22 (.14)	-.25 (.10)
% EAB Neutral		OMT	-.21 (.26)	-.06 (.77)	.10 (.60)	.24 (.21)	-.12 (.52)	.06 (.76)	.11 (.55)
	500								
		Whole sample	-.16 (.08)	.08 (.37)	.05 (.56)	-.15 (.09)	**-.19 (.03)**	-.08 (.39)	-.12 (.18)
		Non-meditators	-.03 (.84)	.21 (.14)	.21 (.14)	-.11 (.41)	**-.32 (.02)**	-.13 (.37)	-.11 (.41)
		Meditators	**-.25 (.03)**	-.03 (.78)	-.08 (.50)	-.19 (.11)	-.12 (.31)	-.07 (.53)	-.13 (.28)
		MaSD	-.28 (.06)	-.03 (.85)	-.19 (.21)	**-.35 (.02)**	-.12 (.43)	-.29 (.05)	-.27 (.07)
		OMT	-.25 (.18)	-.05 (.80)	.11 (.56)	-.03 (.87)	-.19 (.31)	.31 (.10)	.06 (.76)
	700								
		Whole sample	-.16 (.07)	.03 (.74)	.06 (.53)	.03 (.78)	-.14 (.13)	-.09 (.29)	-.03 (.70)
		Non-meditators	.03 (.85)	.23 (.10)	.14 (.31)	-.09 (.51)	**-.30 (.03)**	.09 (.54)	-.06 (.69)
		Meditators	**-.28 (.02)**	-.10 (.42)	.02 (.87)	.11 (.34)	-.03 (.80)	**-.23 (.04)**	.005 (.97)
		MaSD	-.24 (.11)	-.02 (.89)	-.16 (.29)	-.16 (.28)	-.13 (.40)	**-.32 (.03)**	-.26 (.09)
		OMT	-.31 (.10)	-.21 (.27)	.30 (.10)	**.45 (.01)**	.17 (.36)	-.06 (.77)	**.37 (.04)**
	200								
		Whole sample	-.08 (.39)	.07 (.43)	.10 (.25)	.002 (.98)	-.06 (.54)	-.02 (.81)	.01 (.91)
		Non-meditators	.01 (.95)	.12 (.39)	.21 (.13)	.07 (.63)	-.03 (.83)	-.002 (.99)	.07 (.61)
		Meditators	-.12 (.31)	.07 (.55)	.02 (.90)	-.07 (.53)	-.07 (.54)	-.03 (.82)	-.03 (.82)
		MaSD	-.12 (.42)	.05 (.77)	-.08 (.61)	-.29 (.05)	-.04 (.80)	-.19 (.20)	-.18 (.23)
		OMT	-.06 (.75)	.17 (.39)	.22 (.24)	.20 (.28)	-.12 (.53)	.32 (.09)	.26 (.17)
	300								
		Whole sample	-.15 (.08)	.08 (.37)	.16 (.07)	.05 (.56)	-.02 (.85)	-.09 (.29)	.06 (.48)
		Meditation-naïve	.01 (.92)	.18 (.21)	.27 (.05)	.08 (.59)	-.03 (.86)	.04 (.77)	.13 (.36)
		Meditators	**-.27 (.02)**	.03 (.79)	.08 (.51)	.04 (.73)	.008 (.94)	-.21 (.08)	.04 (.76)
		MaSD	**-.33 (.03)**	.02 (.88)	-.04 (.78)	-.27 (.08)	-.12 (.43)	**-.42 (.004)**	-.22 (.14)
% EAB Emotional		OMT	-.26 (.16)	.05 (.79)	.24 (.21)	.31 (.10)	.02 (.94)	.19 (.33)	.30 (.10)
	500								

	Whole sample	-.09 (.34)	.08 (.38)	**.19 (.03)**	.03 (.72)	-.07 (.41)	.02 (.87)	.05 (.55)
	Non-meditators	.11 (.41)	.08 (.56)	**.29 (.03)**	.07 (.62)	-.16 (.26)	.13 (.36)	.09 (.52)
	Meditators	-.20 (.09)	.08 (.51)	.12 (.30)	.00 (.99)	-.02 (.89)	-.07 (.54)	.05 (.66)
	MaSD	-.19 (.22)	.11 (.49)	.02 (.88)	-.29 (.05)	-.19 (.21)	-.21 (.18)	-.19 (.21)
	OMT	-.28 (.14)	.03 (.87)	.26 (.17)	.32 (.08)	.20 (.29)	.15 (.42)	**.37 (.04)**
700								
	Whole sample	-.09 (.32)	-.02 (.80)	.15 (.10)	.10 (.26)	-.02 (.87)	.01 (.90)	.08 (.37)
	Non-meditators	.09 (.52)	.01 (.92)	.23 (.10)	.11 (.45)	-.11 (.45)	.05 (.73)	.08 (.55)
	Meditators	-.15 (.19)	-.02 (.86)	.11 (.33)	.09 (.44)	.03 (.81)	.04 (.76)	.11 (.37)
	MaSD	-.01 (.94)	.003 (.99)	.11 (.48)	-.05 (.75)	-.02 (.91)	-.04 (.80)	.02 (.88)
	OMT	**-.43 (.02)**	-.08 (.66)	.10 (.59)	.18 (.33)	-.07 (.72)	.16 (.39)	.13 (.50)

Table A4. Spearman's Rho correlation coefficients between *Neutral Attentional Blink (%NAB)* and *Emotional Attentional Blink (%EAB)* in the whole sample, Non-meditator group, Meditator group and Meditation Tradition subgroups: Mindfulness as Securely Defined (MaSD) and Other Meditation Traditions (OMT).

***NAB* Magnitude (*%NAB*) per Lag (ms)**	**Group**	***EAB* Magnitude (*%EAB*) per Lag**	
		Neutral Condition	Emotional Condition
200	Whole Sample	**.28 (.001)**	**.31 (<.001)**
	Non-meditators	**.38 (.005)**	**.36 (.007)**
	Meditators	.21 (.07)	**.27 (.02)**
	MaSD	.18 (.24)	.23 (.14)
	OMT	.33 (.07)	.31 (.09)
300	Whole Sample	**.50 (<.001)**	**.43 (<.001)**
	Non-meditators	**.46 (<.001)**	**.52 (<.001)**
	Meditators	**.50 (<.001)**	**.34 (.003)**
	MaSD	**.55 (<.001)**	**.37 (.01)**
	OMT	**.44 (.02)**	.31 (.10)
500	Whole Sample	**.47 (<.001)**	**.53 (<.001)**
	Non-meditators	**.63 (<.001)**	**.63 (<.001)**
	Meditators	**.37 (<.001)**	**.46 (<.001)**
	MaSD	**.53 (<.001)**	**.61 (<.001)**
	OMT	.12 (.54)	.25 (.19)
700	Whole Sample	**.45 (<.001)**	**.37 (<.001)**
	Non-meditators	**.44 (<.001)**	**.36 (.007)**
	Meditators	**.46 (<.001)**	**.37 (<.001)**
	MaSD	**.60 (<.001)**	**.47 (<.001)**
	OMT	.24 (.20)	.22 (.25)

Appendix B. Chapter 6 (Study 2) Supplementary Materials

Figure B. Meditation History Questionnaire (MHQ) – Brief

College of Health and Life Sciences
Department of Life Sciences

Brunel University London

Meditation History Questionnaire

Participant ID: **Date:**

1. How many years have you been practicing meditation?

2. Which tradition of meditation do you follow most consistently?

3. What other traditions are you familiar with conceptually and experientially?

4. Do you have a formal meditation teacher?

5. Please describe your daily meditation routine?

6. Have you attended meditation retreats?

7. What is your main meditation practice?

8. Do you try to practice mindfulness in daily life?

9. What method do you use to bring the mind back if it wandered?

10. Do you ever practice meditation when lying down?

11. Is the quality of the meditation different for you when sitting and lying down?

12. Do you normally practice with your eyes open or close?

13. Do you experience alterations in the perception of space and time during meditation?

14. Did you have experience(s) of the non-dual state?

15. Can you enter a non-dual state easily during practice?

16. If yes, how long are you able to sustain it for (e.g. seconds, minutes, hours)?

17. Are you able to drop into and sustain a non-dual state between the formal practice sessions?

18. Please calculate the total hours of formal practice you have done over the years. This is to be an approximate number of hours of sitting meditation that you have done at home or in group sittings, as well as retreats. If you not sure what to include, please email me with questions. Many thanks.

    Total hours of sitting meditation practice (approximately):

THANK YOU VERY MUCH FOR YOUR TIME

Appendix C. Chapter 7 (Study 3) Supplementary Materials

Table C1: Relationship between *Affective Priming* Reaction Time (*AP* RT) and Trait *Equanimity*

					Equanimity, *r (p)*					
***Affective Priming* Task**					Meditators			Non-meditators		
	Condition		Prime	Duration (ms)	Total	Males	Females	Total	Males	Females
Reaction Time (RT)	Physical	Painful	Happy	28	-.15 (.31)	-.03 (.86)	-.30 (.23)	-.10 (.46)	**-.38 (.02)***	.17 (.49)
				42	-.16 (.28)	.06 (.75)	**-.60 (.009)****	-.10 (.47)	**-.40 (.01)***	.31 (.21)
			Sad	28	.03 (.83)	.21 (.25)	-.29 (.25)	-.05 (.71)	-.31 (.06)	.25 (.33)
				42	-.20 (.17)	.15 (.42)	**-.67 (.003)****	-.09 (.52)	**-.40 (.02)***	.27 (.27)
			Neutral	28	-.06 (.66)	.13 (.50)	-.37 (.13)	-.11 (.44)	**-.41 (.01)***	.27 (.27)
				42	-.04 (.80)	.12 (.52)	-.22 (.37)	-.11 (.44)	-.32 (.05)	.18 (.49)
		Non-Painful	Happy	28	.12 (.43)	.23 (.22)	-.09 (.74)	-.14 (.30)	**-.47 (.004)****	.32 (.20)
				42	-.04 (.78)	.03 (.89)	-.23 (.37)	-.14 (.30)	**-.43 (.008)****	.23 (.35)
			Sad	28	-.03 (.85)	-.06 (.76)	-.08 (.77)	-.16 (.24)	**-.46 (.004)****	.20 (.43)
				42	-.13 (.38)	-.07 (.71)	-.30 (.22)	-.20 (.14)	**-.50 (.002)****	.23 (.36)
			Neutral	28	.09 (.55)	.19 (.31)	-.14 (.58)	-.24 (.07)	**-.48 (.003)****	.06 (.81)
				42	-.07 (.64)	.02 (.94)	-.25 (.31)	-.16 (.26)	**-.43 (.009)****	.23 (.36)
	Emotional	Painful	Happy	28	.19 (.20)	.28 (.13)	.03 (.89)	-.18 (.19)	**-.37 (.02)***	.11 (.65)
				42	.15 (.30)	.19 (.32)	.03 (.91)	-.12 (.40)	**-.36 (.03)***	.28 (.26)
			Sad	28	-.04 (.78)	-.10 (.60)	-.05 (.84)	-.01 (.94)	-.26 (.12)	.39 (.11)
				42	.20 (.17)	.31 (.09)	.05 (.85)	-.17 (.23)	**-.36 (.03)***	.10 (.69)
			Neutral	28	.14 (.33)	.10 (.61)	.14 (.57)	-.11 (.45)	**-.34 (.04)***	.20 (.44)
				42	.01 (.93)	.11 (.54)	-.21 (.41)	-.07 (.60)	**-.45 (.005)****	**.48 (.04)***

		Non-Painful	Happy	28	.09 (.55)	.19 (.31)	-.13 (.61)	-.18 (.19)	**-.55 (.001)****	.35 (.15)
				42	.05 (.73)	.17 (.37)	-.17 (.50)	**-.29 (.04)***	**-.50 (.002)****	.11 (.68)
			Sad	28	-.06 (.68)	.08 (.67)	-.30 (.23)	-.17 (.21)	**-.46 (.004)****	.24 (.33)
				42	-.02 (.89)	.02 (.92)	-.15 (.56)	-.17 (.21)	**-.48 (.003)****	.26 (.29)
			Neutral	28	-.07 (.64)	.10 (.61)	-.37 (.13)	-.17 (.21)	**-.41 (.01)***	.21 (.40)
				42	-.02 (.92)	.08 (.69)	-.21 (.41)	-.24 (.08)	**-.56 (.001)****	.28 (.26)