RACIAL STIGMA, AND SENSE OF AGENCY: IMPLICATIONS FOR NEUROCOGNITIVE AND SOCIAL-COGNITIVE RESEARCH

RACIAL STIGMA, AND SENSE OF AGENCY: IMPLICATIONS FOR NEUROCOGNITIVE AND SOCIAL-COGNITIVE RESEARCH

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Lay Abstract

One of the most fascinating aspects of human consciousness is our ability to *feel* in control of our actions and their outcomes. This experience, better known as a sense of agency, allows us to distinguish our own actions from others and feel responsible for the events we cause in the world. As an important psychological phenomenon, many researchers have taken an interest in understanding how this experience is shaped within our subjective minds. This work has revealed that individual characteristics, as well as social/environmental processes, can affect the sense of agency, at times, even disrupting/impairing the experience. Extending these early findings, this thesis aims to explore the role of psycho-social factors, namely, racial stigma, on the sense of agency. Across five experiments, we reveal that race-based experiences, including perceived and expected racial bias as well as racial acceptance, decrease the sense of agency. With replication and further inquiry, these studies have important implications for the neurocognitive and social-cognitive literature, as well as society at large.

Abstract

As social creatures, our social encounters matter. They matter for how we experience the world, as well as ourselves. The role of psycho-social experiences has recently been recognized in the neurocognitive literature on the sense of agency. Defined as the experience of control over one's actions and outcomes, researchers have begun exploring how social interactions and contextual cues modulate this experience, using an implicit task known as intentional binding. This task claims to capture the sense of agency by assessing differences in perception of time across conditions that are theoretically considered to be higher in sense of agency as compared to those that are lower. Drawing inspiration from this new literature, this thesis explores, across five studies, the impact of different psycho-social experiences, particularly those related to stigmatized racial minority groups, on the sense of agency. Our first two studies (n= 36, n=123) indicate that reflection on both negative and positive psycho-social experiences, including racial stigma, bias, and acceptance, reduces the sense of agency, as indexed by lower action-effect interval estimates. Further, our latter three studies (n=45, n=44, n=44), which focus on North American and international samples, suggest that expectations of racial bias reduce the sense of agency and that this reduction is greatest amongst people who experience a threat to their identity because of the event, as well as people who are low-self monitors. Insights from these studies are used to advance neurocognitive and social cognitive work, including psycho-social modulates of intentional binding and psychological mechanisms that affect racial minorities.

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Declaration of Academic Achievement

This thesis contains five studies that aim to better understand the role of psycho-social modulators of the sense of agency. Chapter 1 provides a high-level overview of the neurocognitive literature on the sense of agency. This chapter ends with a brief introduction to the gap this thesis aims to fill. Chapters 2 and 3 provide a summary of my work on the role of racial stigma, acceptance, bias, and expectations of bias, on the sense of agency. The content in these two chapters is designed to be submitted to one of two journals: Consciousness and Cognition or Frontiers in Consciousness. The final chapter, chapter 4, provides a summary of the research in this thesis and provides some future directions and limitations of this work.

All the studies in this thesis were designed in collaboration with my supervisors, Dr. Sukhvinder Obhi and Dr. Suzanna Becker. The race-based primes in chapters 2 and 3 were conceptualized in collaboration with Dr. Sukhvinder Obhi. I programmed each of the studies using jsPsych. I hosted the studies and collected the data using Cognition.run. I analyzed the datasets using RStudio. The coding schemes were developed in collaboration with four graduated students. I wrote the entire thesis, and revisions were made by both Dr. Becker and Dr. Obhi.

Chapter 1: Neurocognitive research on the sense of agency

Prelude

This chapter provides a high-level overview of the neurocognitive literature on the sense of agency. It focuses primarily on intentional binding research, given this is our main measure of interest. We include key details about advances in the last two decades, to gain an appreciation for the parameters and goals of our work.

1.1 Introducing sense of agency

"Forces beyond your control can take away everything you possess except one thing, your freedom to choose how you will respond to the situation." Viktor Frankl

Nested within the poetry we read, the television shows we watch, and the podcasts we listen to are stories of perseverance. When we are confronted with a challenge, we are taught that we have the choice to either dwell on the problem or pick ourselves up and move forward. The ability to mobilize ourselves is said to rest on will; that is, we can move forward if we make the intention to do so and follow up on the intention with the correct course of actions.

While the basic assumption of free will has been challenged in the neurocognitive literature (Libet, 1999; Pereboom, 2003), researchers have stated that people still seem to *feel* as though they are agents, and it is this feeling that drives many of the actions and choices we make daily (Crivelli & Balconi, 2017). At a foundational level, this *sense of agency* has been shown to underlie volition (Haggard, 2017), allowing people to distinguish their own actions

from those made by others (Jeannerod et al., 2004; David et al., 2008) and feel responsible for the outcomes of their actions (Haggard, 2017; Leptourgos & Corlett, 2020). Furthermore, disruptions to the experience have been linked with feelings of helplessness (Haggard & Chambon, 2012), and dissociation from one's surroundings (Bregman-Hai et al., 2020); and irregularities in agentic processing have been observed across psychiatric conditions, including schizophrenia (Hughes et al., 2013; Leptourgos & Corlett, 2020), depression (Haggard & Chambon, 2012; Obhi et al., 2013), narcissistic personality disorder (Hascalovitz & Obhi, 2015), as well as movement disorders, such as Tourette's syndrome (Rowe & Wolpe, 2015; Singer, 2005; Zapparoli et al., 2020). Given the role of sense of agency in facilitating basic human experiences, as well as the cost of disruption, researchers have taken a keen interest in understanding this experience empirically.

1.2 Empirical investigation of the sense of agency

In an ideal world, mental phenomena would be assessed in a manner that replicates real-life experiences. However, given the complexity of the human condition and methodological constraints, researchers must follow rigorous processes to draw meaningful conclusions (Roskam, 1989). Empirical research must operationalize the construct of interest, select validated measures to assess it, and, in the case of experimental work, apply appropriate constraints to limit the influence of confounding variables.

Within the neurocognitive literature, the sense of agency is defined as the experience of control over one's actions and, through them, their outcomes in the world (Moore, 2016). It is operationalized as the experience that accompanies action preparation, execution, and the consequence/outcome of an action (Haggard, 2017). The term action is used here rather than

behaviours, as actions are intentional and goal-directed movements and subsequently linked with sense of agency, as compared to other behaviours, such as reflexes or involuntary behaviours, which are not by their nature purposely controlled and, thereby, not associated with a sense of agency (Balconi, 2010). This distinction is important, as it underlies how empirical paradigms that measure sense of agency are designed. Namely, within the literature, most measures prompt participants to engage in a simple voluntary action, such as drawing a line, pulling a lever, or making a keypress, which triggers a perceptible outcome. By engaging in these actions, at the time of their choice, researchers suggest that these paradigms promote a sense of agency, which they can then measure empirically using one of several neuroimaging (Haggard et al., 2002), behavioural (Imaizumi & Tanno, 2019) or kinematic tools (Kalckert & Ehrsson, 2012). Here, we focus on behavioural tools.

Behavioural measures of sense of agency

Behavioural measures of sense of agency can be grouped into two broad categories: explicit and implicit measures (Dewey & Knoblich, 2014). Both measures are structured in a similar manner. They begin by asking participants to engage in a voluntary action, observe a sensory outcome (often auditory or visual) and report about specific aspects of their experience. The critical point of distinction between the two groups of tasks is the final component, that is, the sensory experience participants are asked to report on.

With explicit tasks, participants are asked to report the extent to which they perceived being involved in generating a given outcome (Bussche et al., 2020). Specifically, they may be asked to report whether they believed they caused an event (action recognition judgments) (Moore, 2016; Stern et al., 2020; Synofzik et al., 2010) or assess the degree of agency they felt

over a given outcome (using a 5-point or 7-point Likert scale) (Sato, 2009; Sidarus et al., 2013; Barlas & Obhi, 2014; Barlas et al., 2017, 2018). These tasks claim to capture people's experiences of agency directly, such that higher self-reported judgments of agency are deemed indicative of higher levels of sense of agency.

With implicit tasks, including sensory attenuation and intentional binding, participants are asked to make perceptual judgments on self-generated and externally generated action effects (Dewey & Knoblich, 2014). Interest in these judgements stems from theoretical and empirical work, which has suggested that when people accurately predict action-effects, there is a change in the way they experience sensory outcomes (Hughes et al., 2013). Namely, sensory attenuation, which refers to the perceived reduction in the intensity of self-generated outcomes as compared to other-generated outcomes (Blakemore et al., 1999, 2000; Tsakaris & Haggard, 2003) is said to emerge as a result of the brain dismissing highly predictable outcomes (i.e., self-generated outcomes), and increasing the salience of less predictable outcomes (i.e., other-generated outcomes), as these outcomes are more likely to be related to biological threat (Blakemore et al., 1999; Pyasik et al., 2021). Similarly, intentional binding, which refers to the perceived *reduction* in time between voluntary actions and sensory outcomes, as compared to the time perceived between an action and an audible tone alone, as well as externally generated sensory outcomes (Haggard et al., 2002; Malik & Obhi, 2019) is said to emerge, due to an accurate "match" between internal motoric predictions of sensory outcomes and actual sensory consequences (Haggard & Tsakiris, 2009; Moore, 2016). Together, both sensory attenuation and intentional binding have been suggested to assist in disentangling self-generated outcomes from externally-generated outcomes (Pyasik et al., 2021) and represent

psychological mechanisms through which the brain and mind create a coherent sense of agency (Tsakaris & Haggard, 2003; Kearney & Brittain, 2021).

The use of behavioural measures in research

The decision to use either explicit or implicit tools in research is informed by theoretical and empirical work on the phenomenology of the sense of agency. Ongoing research has suggested that the sense of agency is a multifaceted experience (Pacherie, 2007; Gallagher, 2012) that can be experienced at a pre-reflective and reflective level (Synofzik et al., 2008). Pre-reflective sense of agency, also known as feelings of agency, refers to the basic, low-level, and non-conceptual awareness of being an agent (Moore, 2016). Drawing on sensorimotor cues, the sense of agency at this level is said to characterize our voluntary actions in what feels like an automatic manner, and the onset of this experience is said to allow us to seamlessly interact with our environment (Malik et al., 2022). In contrast, reflective sense of agency, also known as judgments of agency, denotes higher-order and conceptual interpretations of agency (Moore, 2016). Within our daily encounters, this experience allows for retrospective understandings or explanations of behaviours or events (Buhrmann & Di Paolo, 2017). Drawing on higher-order processes, the sense of agency at this level can allow one to determine their role in a particular event and can inform self-narratives and beliefs (Graham & Stephens, 1994; Gallagher, 2012).

The fact that explicit tools require participants to reflect and introspect on their involvement in a given event has led researchers to accept these group of tools as important for assessing the reflective sense of agency (Tapal et al., 2017; Zito et al., 2020). Further, the indirect nature of implicit tools is suggested to allow researchers to “tap into” agentic processes without having participants aware of the construct being assessed (Lynn et al., 2014; Haggard,

2017). This discrete method of assessing the sense of agency has led researchers to recognize this tool as a good measure of the pre-reflective sense of agency (Cavazzana et al., 2014).

1.3 Intentional binding

When considering the neurocognitive literature on the sense of agency, it should be noted that the development of implicit tools has been a relatively new occurrence. Because of this, there have been relatively fewer insights into the mechanisms through which these tools capture the sense of agency and, subsequently, the factors that modulate the pre-reflective sense of agency. That said, considerable advancement has been made over the last two decades (Malik et al., 2022), leading to important insights into the neurocognitive origins of the experience, as well as important psychological (Borhani et al., 2017) and social insights (Weiss et al., 2011). We aim to touch on some of these contributions, particularly the contributions of intentional binding, as this tool is suggested to be one of the most widely used implicit tools (J. Moore, 2016), and it is also the tool we use in this thesis. However, before we can introduce these contributions, it is important to provide a more thorough overview of the tool, including how the tool was developed and how it is being used in the current literature. We will delve into these subjects in the coming sections.

Developing the intentional binding task

The field of psychology has a long tradition of using temporal perception to assess internal processes. Credit for this research method is often ascribed to Wilhelm Wundt, also known as “the father of psychology”, who used a pendulum to determine the speed of thoughts (Barrett, 2009; Kim, 2006; Wontorra, 2013). As it relates to the present work, an important tool that has been used to measure temporal perception is the Libet clock.

Developed by a team of consciousness researchers to assess human volition (Rowe & Wolpe, 2015), the analogue clock was designed to have a dial marked by 12 reference points, each mark representing a 5-second interval, as well as single arm which was programmed to rotate across the entire dial in 2560 milliseconds (Ivanof et al., 2021). In the seminal paper on the tool, researchers used the Libet clock to assess the temporal perception of intentions regarding a voluntary action, awareness of the voluntary action and the time a somatosensory stimulus was presented (Libet, 2002; Libet et al., 1983). In conjunction with neuroimaging and EMG techniques, this line of work revealed important discrepancies between 1. actual and perceived time of voluntary actions, 2. actual and perceived time of somatosensory stimuli and 3. perceived time of intention and neural preparation (Libet, 1999, 2002; Libet et al., 1993). Extending this work, a few decades later, a group of neurocognitive researchers drew on the Libet clock to better understand people's subjective experiences during voluntary actions. These researchers were especially interested in uncovering the relevant mechanisms that bind together sensorimotor processes to elicit a coherent stream of consciousness during voluntary actions (Haggard et al., 2002). To understand this topic, researchers focused on the perceived time of various actions and sensory outcomes across several sessions.

During their initial experiment, researchers placed participants through four conditions: two operant conditions (operant-action and operant-outcome) and two baseline (baseline-action and baseline-outcome) (Beck et al., 2017). These conditions all began in the same manner, i.e., with the presentation of the Libet clock. During the operant conditions, participants were asked to make a voluntary keypress at a time of their choice, which would trigger an auditory tone after a brief delay (250 milliseconds). For the operant-action condition,

participants were asked to report the time of the action, and for the operant-outcome condition, they were asked to report the time of the tone (Haggard et al., 2002). During the baseline-action condition, participants were asked to make a keypress and report the time of the keypress, and during the baseline-outcome condition, they were asked to listen to a tone and report the time of the tone.

The key finding from this initial study was a perceived compression of time between a voluntary action and the outcome of that action, or what is now known as the "intentional binding effect" (Tanaka & Kawabata, 2019). The compression reflected two shifts in time perception. When an action and effect were presented together, the action was perceived as occurring later (action shift), while the outcome was perceived earlier (outcome shift), compared to when the perceived events are examined in isolation. In other words, the temporal shift was contingent upon whether the action and effect were presented alone (baseline conditions) or whether they occurred together (operant conditions).

Curious to understand whether this effect was driven by volition, researchers administered two additional studies. These studies inquired about temporal perception during involuntary behaviours. Should participants demonstrate intentional binding during these sessions, researchers would infer that the effect was not driven by volition. Rather, they may infer that this perception was simply a part of processing people's bodily movements. However, if these sessions revealed that the compression of time (or binding) was isolated to voluntary action, then there would be room to infer this experience to be driven by volition. To elicit involuntary behaviours, researchers used transcranial magnetic stimulation (TMS). The TMS

induced movements in the form of a twitch, and participants reported the time of the behaviour. To control for the auditory click elicited by the TDCS machine, a sham-TMS condition was also included. This condition was characterized by anodal stimulation over the left parietal cortex, which triggered no observable changes in muscle activity or perceptual experiences. The only perceptible outcome was a click. These latter studies revealed that involuntary behaviours evoked by brain stimulation did not produce the binding effect (Tanaka & Kawabata, 2019). Instead, involuntary behaviours revealed perceptual shifts in the opposite direction, i.e., behaviours were perceived as occurring earlier, and outcomes were perceived later compared to when they were produced independently (Haggard, 2008).

Altogether, these lines of research revealed a clear distinction between the subjective experience that accompanies voluntary actions and involuntary behaviours. These findings were important as they echoed conceptual understandings of the necessary conditions for sense of agency to arise (Haggard, 2017). To experience a sense of agency, individuals need to experience a level of volitional control over their movements (i.e., being the source of the action) and ownership over the body/limb that moved. This level of control cannot emerge over actions that occurred because of external influence. The main takeaway from this seminal paper, was that intentional binding may be responsible for how the brain connects intentions, actions, and outcomes to generate a sense of agency (Tsakaris & Haggard, 2003).

Intentional binding in the current literature

Since the seminal study on intentional binding, there has been considerable interest in the measure (Moore & Obhi, 2012). Interest in intentional binding comes from both

researchers who have accepted the effect as an implicit measure of the pre-reflective sense of agency (Saito et al., 2015; Howard et al., 2016; Christensen et al., 2019; Bussche et al., 2020), as well as skeptics, who are not yet convinced of the link between intentional binding and sense of agency (Stetson et al., 2006; Kirsch et al., 2018; Suzuki et al., 2019; Klaffehn et al., 2021). Both types of researchers have played an important role in advancing the field, as they have prompted key insights into the nature of the effect and even led to the development of a modified version of the tool.

The nature of intentional binding

Interest in the nature of the intentional binding effect has revealed important insights about the role of action binding as compared to outcome binding. Namely, the revelation that action binding, that is, the perceptual shift of the time of one's action to an outcome, and outcome binding, that is, the perceptual shift of time of the outcome of one's actions to an action, are dissociable processes (Render & Jansen, 2021), has led researchers to investigate these processes independently (Wolpe et al., 2013; Wolpe & Rowe, 2014). This line of research has recently been summarized in a meta-analysis, and a key insight from this work is that action binding is strongly related to the level of control individuals can execute over an outcome, while outcome binding is intimately linked with the predictability of an outcome (Tanaka & Kawabata, 2019).

Other work on the nature of the intentional binding effect has revealed key insights into the parameters of the effect. This work has been summarized in a recent review paper, which has suggested that intentional binding is robust when three conditions are met: a) an action is

intentional, b) predictable, and c) there is temporal contiguity, i.e., the action and the outcome generated are close in time (Malik et al., 2022). The first condition is one that we've noted before in this chapter. As stated in section 1.2, voluntary actions are goal-directed and linked with a sense of agency, while involuntary behaviours are not. Similarly, as we noted in section 1.3.1, the seminal paper on intentional binding revealed that the effect was observed during intentional, *voluntary* actions but not unintentional, *involuntary* behaviours (Haggard et al., 2002). Extending this idea, other research has even shown that when an intention is interrupted by an involuntary behaviour, people do not demonstrate binding for the generated sensory outcome (Haggard & Clark, 2003). That said, recent work has shown that people may experience binding between involuntary actions and outcomes if self-causation is implied (Dogge et al., 2012). As it relates to outcome predictability, researchers have demonstrated that under conditions where an action-outcome is less predictable (i.e., 50% of trials have a predictable outcome), participants only show intentional binding for trials that have a perceptible outcome (tone) but not those that do not. In contrast, under more predictable conditions (i.e., 75% of trials have a predictable outcome), participants demonstrated intentional binding for both trials that had a sensory outcome as well as those that did not (Moore et al., 2009). As it relates to temporal contiguity, researchers have found greater binding for actions and outcomes that are separated by a shorter delay as compared to longer delays (Haggard et al., 2002; Ebert & Wegner, 2010; although refer to Nolden et al., 2012; Wen et al., 2015 for alternative conclusions).

Types of tasks that assess intentional binding

The intentional binding effect has been measured in the literature using two tasks (Moore & Obhi, 2012). The first is the traditional Libet clock model, which we have explained previously. Modern researchers using this task often replicate the research methods of the first study in the seminal, whereby participants undergo an operant-action, operant-outcome, baseline-action, and baseline-outcome. The TMS and Sham-TMS conditions are not often used, as the effect has already been verified to rely on voluntary actions. The second version is an adapted measure known as the condensed or interval estimate version of the intentional binding task (Moore, 2016). This version differs from the traditional Libet clock method in that each trial requires participants to make direct estimates of time about action-outcome effects. Namely, for each trial of the task, participants are provided the opportunity to make a voluntary action (keypress), which generates an outcome (tone) after a delay sometime between 0 and 1000 milliseconds (Imaizumi & Tanno, 2019). As it relates to temporal estimates, participants are asked to report on the duration of time between the two events.

Each block of the condensed intentional binding task includes multiple trials. The exact number ranges between some studies. For example, Howard and colleagues (2016) relied on 20 trials per block, while Jenkins & Obhi (2021) used 24 trials, and Imaizumi & Tanno (2019) used 30 trials per block. This version of the task is often used in an experimental context, whereby participants undergo one block of the task, followed by an experimental manipulation, another block. Across these conditions, average interval estimates are calculated for each block and compared to extrapolate interpretations about changes in the sense of agency. Conditions that are characterized by lower average action-effect estimates (i.e., lower perceived time between

an action and outcome) are interpreted to suggest greater experiences of sense of agency, as compared to conditions that are characterized by greater average action-effect estimates.

To ensure that changes in temporal estimates represent changes in sense of agency, rather than changes in temporal perception, recent researchers have started to include either a separate control group or condition to assess the impact of a manipulation on simple temporal perception (Poonian & Cunnington, 2013; Imaizumi et al., 2019; Malik & Obhi, 2019). For these conditions, participants are placed in a similar context to the intentional binding task; however, instead of making a voluntary key press for each trial, the computer generates an auditory tone, which then prompts a second auditory consequence. Participants engage in this "two-tone task" prior to manipulation and after, and changes in temporal perception for this task are compared to changes in temporal perception of the intentional binding task. Evidence of a significant difference in the temporal estimate post-manipulation, but no significant difference in temporal perception for the two-tone task, is taken to suggest that the manipulation affects sense of agency.

It is important to make clear here that the condensed version of the task has arisen based on some critique against the Libet clock method. For one, researchers have critiqued the way this task assesses temporal perception between actions and outcomes. The use of four conditions to calculate this score, rather than to directly assess the experience has been considered a limitation of the task (Moore & Obhi, 2012). A second critique, which is more about the literature, is that for the Libet clock, it is critical for researchers to be consistent with the type of click used for this task. Namely, researchers must pay attention to the clock markings, how the intervals are spaced, the shape of the clock, the colour of the clock hand,

and whether the numbers are marked. Current challenges in the uniformity of the task have been said to challenge the replicability of certain findings and, in turn, limit the advancement of the literature (Ivanof et al., 2021). The condensed version of intentional binding remedies these concerns as it inquires about the time between an action and outcome directly, and it does not rely on a clock to make these temporal estimates. Additionally, the value of the condensed task is in its ability to be administered and analyzed quickly. However, the efficiency comes at a cost, and that is that it does not capture as many details as the Libet clock. The Libet clock provides insight into action and outcome binding, as well as intentional binding, and this information is important to understanding whether subjective experiences were driven by action or tone binding.

Recognizing the pros and cons of each version, it may be argued that researchers who are interested in simply assessing sense of agency should rely on the condensed version, and those who would like to also understand the mechanisms that underlie the experience may depend on the Libet version. This is, of course, not a hard and fast rule, as researchers also need to consider the study's length, the general research design, and which task may be best suited for the attention and capacity of the demographic of interest.

1.4 The emergence of sense of agency with evidence from intentional binding

Perhaps the most intriguing question within the entire neurocognitive literature on sense of agency, is *how* the sense of agency emerges in the mind. This question has been critical to not only mobilizing theoretical models, but also empirical work (Malik et al., 2022). Within the current literature, research insights have been mobilized by two key models (Moore, 2016). The first is a predictive position rooted in the computational mechanisms of motor

control, and the second is a retrospective account which is rooted in unconscious causal pathways (David et al., 2008). The goal of this section is not to fuel the debate on which is more accurate. Instead, we demonstrate the contributions of these models to our current understanding and even showcase the role of multifactorial models, which draws on learnings from both models. In this section, we provide an overview of each model and summarize insights from intentional binding work, which has mobilized empirical understandings of these models.

A prospective account; examining the comparator model of agency

The prospective account provides one interpretation of how the sense of agency arises (Moore & Obhi, 2012). The most common prospective account is the central monitoring theory (or comparator model of agency). This theory suggests that sense of agency relies on the same processes that underlie motor control. Notably, the same models that allow for the experience of control during voluntary actions (i.e., inverse models and forward models) also impact the awareness of one's actions and informs the sense of agency (David et al., 2008; Carruthers, 2012). To explain the role of the *proposed* predictive component of the motor control system and its subsequent role in generating a sense of agency, we reflect on a view of the motor control system that has a predictive component and one without it.

Starting with a motor control system devoid of a predictive component, if this type of system was involved in generating human actions, each voluntary action would begin with a goal state (or motor intention), which would provide the motor control system with a mental representation of what the final position of the system should look like (Moore, 2016). The motor intentions would then be fed to the system's controllers, which would be used to

execute a motor command and trigger a movement. As the movement changes the state of the motor system, it would then generate sensory feedback, which the system would use to estimate the new state of the motor system. Both the estimated and desired state would then be compared (at the comparator), and if there was a match, this would mean the intended action was achieved, and there would be no need to process the command further. However, if there was a mismatch, the motor system would need to send an updated motor command and correct the action, and this process would continue until the motor system reached the intended state.

The limitation of this model is that it depicts the motor control system as a sub-optimal system, whereby the process through which it detects and corrects errors is cumbersome and time-consuming. These qualities directly contrast the way people act in the real world, which is often quick and seamless, with few errors. Recognizing this discrepancy, researchers have suggested that the motor control system must have a predictive component to support people in successfully executing goal-directed actions and quickly remedying errors if/when they occur (Frith et al., 2000).

A motor control system with a predictive component is suggested to draw on motor commands to develop "efference copies," which are then used to predict a) the future state of the system and b) the sensory consequences arising from the change in the system. Together these predictions are said to form a representation of the motor control system that can be used to make two important comparisons: 1. A comparison between the prediction of the future state and the actual state of the system, which is said to prompt adjustments in motor actions, and 2. A comparison between the prediction of the future state and the actual state of

the system, which is said to be related to people's experience of agency (Moore & Obhi, 2012). Specifically, a person is said to experience self-attributed agency if the predicted and actual sensory outcomes are congruent (Hughes et al., 2013). A match between the predicted and actual sensory outcomes is said to cancel out the effect of the sensation that was generated by a person's actions (Blakemore et al., 2000). In contrast, a mismatch between the two signals is said to suggest that the outcomes were not self-generated and thereby reduce the sense of agency (David et al., 2008). In sum, this model suggests that to experience a sense of agency, there needs to be no prediction error (Haggard, 2017).

Currently, there are several lines of research that support the prospective account. The most apparent line of support is the finding that the intentional binding task is specific to voluntary actions (Moore & Obhi, 2012). An additional line of support is the link between intention and intentional binding (Haggard & Clark, 2003). Researchers have found that when intentions are disrupted, individuals experience reduced binding. A third line of support is research indicating an association between outcome probability and intentional binding (Engbert et al., 2008). Higher outcome probability is related to a stronger binding effect. This effect of probability persists even when there is no outcome. These findings suggest that the mere prediction of an outcome is enough to produce the binding effect.

A retrospective account; examining the theory of apparent mental causation

The retrospective account suggests that we rely on general inferential processes to determine the cause of an action or outcome (Moore & Obhi, 2012; Leptourgos & Corlett, 2020). A popular interpretation of the retrospective account is the theory of apparent mental causation. The theory rules out the widespread belief that intentions *cause* voluntary actions.

Instead, it suggests there are two unconscious causal pathways that are in control of such actions (Wegner & Wheatley, 1999). One pathway interacts with the motor control system to trigger voluntary actions, and the other elicits intentions and thoughts related to an action. Additionally, some conscious factors, such as the observable action, are also believed to influence voluntary actions. However, these are not causal factors.

As it relates to the sense of agency, this theory suggests that this experience is determined by the relation between thought and action (Moore, 2016). To feel a sense of agency, three conditions need to be met: "1. the intention occurs prior to the action, 2. is consistent with the action, and 3. is the most plausible cause of the action" (Moore & Obhi, 2012). Based on these criteria, sense of agency registered retrospectively or postdictively. To rephrase this, researchers suggest the experience is inserted into consciousness after the action has been executed. In some work, this insertion is referred to as consciously "edited in" after the fact (Wegner & Wheatley, 1999; Wolpe & Rowe, 2014) Initial support for this account has come from research examining the impact of priming. Within the study, when participants were primed to think about future actions, they demonstrated increased sense of agency. Recent support comes from research on beliefs. Simply, the study revealed that causal beliefs influence pre-reflective sense of agency (i.e., intentional binding) (Desantis et al., 2011).

Multifactorial accounts of sense of agency

The comparator model and theory of mental causation have motivated much of the current discussions on the origins of sense of agency. While the theories suggest contrasting perspectives, both have garnered empirical support (Yoshie & Haggard, 2017). In considering

the seemingly opposing literature, recent researchers have revisited these models and drawn on old and new research to develop more fitting theories. As a result, current researchers have proposed a more holistic account of the experience in question. Of the models proposed, two have gained recent attention: the cue integration theory and the two-step multifactorial account (Moore et al., 2009; Moore & Fletcher, 2012; Synofzik et al., 2008).

The cue integration theory suggests that both predictive and retrospective inferences are important for the experience of agency (Moore & Fletcher, 2012). Particularly, the sense of agency is said to be informed by several sources of information, known as agency cues. The agency cues go through a weighting process. Of the available cues, the most reliable are selected and integrated to produce an optimal cue combination (Moore et al., 2009). Not only can cues interact to impact agency experience, but they can also provide independent contributions. There are several factors that can alter the way cues are weighted. For instance, individual differences and contextual differences are some important factors of influence.

Evidence for this view comes from the impact of external influences on intentional binding (Haggard, 2008). Previous research denotes that when the reliability of sensorimotor predictions decreases, external action outcomes have a more pronounced impact on intentional binding. Other evidence supporting this theory is research on agency judgements and psychopathology (Synofzik & Voss, 2010). Previous studies have revealed that schizophrenic patients have unreliable sensorimotor predictions. Considering the cue integration theory, it would make sense that patients focus more on outcome cues rather than internal cues (Moore, 2016). Results from a study by Synofzik and colleagues (2008) provide

support for this prediction. Their study found that visual feedback rather than internal sensorimotor cues predicted agency attribution in individuals with schizophrenia.

The second theory that has gained acceptance is the two-step multifactor account by Synofzik and colleagues. The details discussed in this theory are not foreign to our discussion so far. It is this theory that first posed the distinction between pre-reflective sense of agency or feelings of agency (FoA) and reflective sense of agency or judgements of agency (JoA) (discussed under section 1.2.2). The two-step multifactorial account suggests that the mind integrates information from reflective and pre-reflective sources, such as beliefs and knowledge and motoric cues, respectively (Karsh et al., 2016). Feelings of agency are considered a result of weighing and integrating different indicators related to action-related authorship (for example, feed-forward cues, proprioception, and sensory feedback). When the indicators are congruent, meaning the predicted and sensory outcomes match, the indicators no longer require further processing, and we experience a diffuse sense of agency through a continuous flow of action execution. Should there be incongruence, action is registered as unusual or unexpected, and there is a sense that it was not done by "me." Judgments of agency are believed to draw on feelings of agency. The pre-conceptual feelings are processed further to consciously form agentic attributions. For example, if we consider a mismatch at the sensorimotor level, this experience is further processed at the judgment level. At the higher-order conceptual level, several interpretive mechanisms (ex. beliefs, attitudes, and desires) work together to find the best explanation for the experience. Understanding a mismatch consciously often leads to one of two outcomes: the agent believing they were the author despite the mismatch or an external attribution of cause. When external attributions occur, the next step is attributing the action to

a source. Drawing on contextual cues and beliefs, the final step comes down to "ad hoc theorizing about oneself" (Vosgerau & Newen, 2007) We may rely on deeply personal ideas about who we are or the situations we are in, to attribute agency to ourselves or externally.

In exploring the link between FoA and JoA, researchers have suggested that while the processes are dissociable, they both play an important role in what we consider agentic experience. A key piece of this model that we have yet to discuss is the importance of the environment in how agency is processed. When individuals are in a stable and unambiguous situation, feelings of agency are suggested to be the primary source of agentic experience we rely on. Thus, FoA is taken at face value. Under ambiguous situations, however, JoA is said to play a primary role. Under these situations, individuals may draw on prior beliefs, and these beliefs can override FoA. In sum, this theory considers the impact of both bottom-up and top-down processing on agentic experience (Synofzik et al., 2008).

1.5 Modulators of intentional binding

Theoretical accounts of intentional binding have suggested that the sense of agency can be modulated, at any time, by top-down and bottom-up cues, which can shape agentic experience prior to an action (prospective) or after the action (retrospectively) (Malik et al., 2022). This theoretical account has been mostly supported by empirical research, except for the role of retrospective top-down cues. To date, we are not aware of any research that has examined how these cues can modulate the sense of agency retrospectively. We attribute the empirical neglect of these modulators to the fact that research on top-down factors is relatively recent. For a long time, researchers were mainly focused on bottom-up cues and understanding

whether these cues prospectively or retrospectively shape the sense of agency (Takahata et al., 2012; Synofzik et al., 2013; Sidarus et al., 2017). That said, recent work has started to explore the role of top-down factors, primarily as prospective cues. For example, researchers have explored the role of personality (Hascalovitz & Obhi, 2015), social context (Villa et al., 2022), and action choice (Chambon et al., 2013) as a few examples of top-down factors. In this thesis, we aim to extend this line of work primarily by examining how psycho-social factors modulate intentional binding. To elucidate our motivation and the direction of our work, we provide a brief overview of some recent evidence which has piqued our interest.

Top-down social and psycho-social modulators of intentional binding

As social beings, researchers have taken a keen interest in how people's social experiences can shape their sense of agency, as indexed by intentional binding. For example, some researchers have investigated the impact of different types of social interaction on intentional binding (Silver et al., 2020; Villa et al., 2022). One line of work has examined the role of engaging in joint actions, and this work has suggested that people can experience a sense of joint agency for actions they co-coauthor. This claim is based on similar intentional binding scores for self-generated and joint actions (Jenkins et al., 2021). Another line of work has explored the impact of commanding an action and its impact on the leaders' sense of agency. This work has shown that leaders experience similar binding for their own actions and their followers' actions (Pfister et al., 2014).

Other researchers focused on the impact of negative social experiences, which have previously been found to lead to adverse psychological outcomes. For example, one group of

researchers has focused on the impact of coercion on the sense of agency (Caspar et al., 2016). Within their work, these researchers assessed peoples' sense of agency for actions that harmed others. Across two experiments, they explored the difference between these actions when performed out of free will as compared to under coercion. In the first experiment, participants were put into pairs and assigned to either the financial harm (group 1) or the physical harm (group 2). Participants went through two control (active and passive) and two experimental conditions (free-choice and coercion). The control conditions were marked by passive control (the experimenter pressing the participant's finger to make a keypress) and active control (the participant making a keypress). These studies revealed that under coercion, participants experienced a reduction in intentional binding (reduced agency). When participants were coerced to act in a harmful manner, their intentional binding scores were more like the passive condition than the free-choice condition. Further, researchers suggested that these coercive actions prompted a type of cognitive distancing.

Extending this line of work, researchers have explored the impact of coercion within strict social hierarchies (Caspar et al., 2020). To adequately assess the impact of rigid hierarchies, researchers focused on military personnel, as this group is often required to submit to the command of a superior. In an initial experiment, researchers examined the impact of free choice and coercive conditions on both healthy participants and junior cadets. This experiment revealed that while healthy controls demonstrated a reduction in binding under the coercive condition, as compared to free-choice, junior cadets demonstrated similar intentional binding across the conditions. Follow-up analyses revealed that the trend of junior cadets was due to longer action-effect interval estimates during the free-choice condition, i.e., a lower sense of

agency. In a second study, researchers sought to explore whether long-term experience within these rigid conditions, as well as people's status, may affect their level of agency. For this study, researchers drew on junior cadets, senior cadets and privates. This experiment replicated the results for junior cadets and similar trends for privates but revealed that senior cadets showed greater sense of agency, i.e., intentional binding, during the free-choice condition. From these findings researchers suggested that within strict hierarchical environments, both the duration of time under these conditions, as well as the role and level of responsibility people are afforded, can influence their experience of agency.

Another group of researchers have focused on the role of adverse social contexts and the impact of short-term and long-term exposure to uncertain/unpredictable environments. Within this line of work, researchers had participants undergo two behavioural training paradigms: a long version and a short version (Soral et al., 2021). The shorter paradigm consisted of 6 questions, while the longer paradigm consisted of 12 questions. Participants were to report the pattern that existed across two images. Participants responses were met with either positive or negative feedback. The feedback was pseudorandomly presented to elicit feelings of helplessness. So, no matter what the participants did, they could not truly identify the pattern (as there was no pattern). Within this study, researchers found that control deprivation not only reduced binding, but the reduction occurred on a gradient. In comparison to short-term uncontrollability, long-term exposure led to an even greater reduction in binding.

Lastly, and of particular interest, in this thesis, is research on negative psycho-social experiences. Emerging research has started to explore the role of experiences such as

powerlessness and social exclusion, given their impact on psychological and behavioural outcomes (Malik & Obhi, 2019). Both lines of research have relied on the episodic recall task, which prompts participants to recall a time when they felt powerful/included and a time when they felt as if they had no power or were powerless/excluded. This task was chosen to manipulate perception, as previous work, has suggested that these primes induce mental states that activate similar cognitive processes to when the event occurred (Galinsky et al., 2003; Obhi et al., 2012). Researchers investigated the impact of these manipulations by examining pre-manipulation action-effect interval estimates to post-manipulation action-effect interval estimates. Across both studies, researchers found that participants reported greater action-effect interval estimates and post-negative psycho-social experience manipulation, as compared to positive psycho-social experience and baseline.

1.6 Current work

The important link between disrupted and impaired sense of agency and mental illness and social dysfunction leads us to want to explore the impact of disruptors of agency further (David et al., 2008; Moore, 2016). Drawing inspiration from the recent work on negative psycho-social experiences, we are particularly interested in examining experiences that have been previously found to negatively affect people's behaviours and well-being. Drawing insight from the work on military individuals, we are interested in examining these experiences amongst people who may be most prone to their impacts. Namely, we aim to focus on the impact of stigma, that is, a marker of devaluation that is placed by society on social groups, which often leads them to be ostracized and excluded from society (Goffman, 1963; Link & Phelan, 2001). We aim to understand the role of this experience on intentional binding by

exploring its impact amongst a stigmatized group, which has been found to exhibit adverse personal and social outcomes across diverse domains and society. i.e., racial minorities.

To start, we plan to assess this experience amongst a convenience sample and then, based on these findings, investigate the experience amongst a representative group (Chapter 2). Based on the findings from both studies, we will then plan the next steps (Chapter 3). We believe that the findings from our research are essential to the neurocognitive literature on intentional binding, as this work will reveal important insights into how sense of agency is modulated across diverse groups.

Chapter 2: Exploring the role of racial stigma on the sense of agency

Prelude

This chapter was written to be submitted to either Consciousness and Cognition or Frontiers of Consciousness. As a result, we've drafted this chapter based on the expertise and interest of these readers.

2.1. Introduction

Humans are agentic beings. We can act, react, and adapt to the changing conditions of the world (Bandura, 2001). Our ability to engage in an autonomous manner rests on a low-level awareness of control over our actions and their outcomes (Gallagher, 2007, 2012). This experience, commonly known as the sense of agency, characterizes our voluntary actions as a feeling. Namely, we tend to *feel* as though we are in the driver's seat, guiding our voluntary actions to their intended outcomes (Moore, 2016).

An intriguing aspect of the sense of agency is that it can emerge in the mind without any conscious reflection on our limbs in space or the events in the world. At a phenomenological level, this experience emerges automatically when we engage in voluntary actions. That said, the intensity of the experience can change across time, situations, and even people. We may feel more or less agency across diverse situations.

The nature of the sense of agency, including how it emerges and how it is modulated within the brain and mind, has captivated diverse scholars (Schlosser, 2015; Malik et al., 2022). In the cognitive sciences, considerable progress has arisen, in part, by the revelation of a perceptual marker that accompanies volitional actions (Haggard, 2017). This marker, often

known as intentional binding, represents a subjective compression of time between actions and outcomes that are intentional and voluntary as compared to those that are unintentional and involuntary (Haggard et al., 2002; Jenkins et al., 2021).

The link between intentional binding and sense of agency was originally proposed in a research paper on the consciousness of action (Haggard et al., 2002). In this paper, researchers suggested that the perception of time between one's actions and outcomes may represent mental processes that allow the brain to distinguish action-outcome pairs that can be *plausibly* linked with our agency from those that cannot. Intentional binding, in specific, was said to represent a mechanism through which the mind connects intentions, actions, and outcomes to create a coherent sense of agency (Tsakaris & Haggard, 2003). Over the last two decades, these early interpretations have been supported by both theoretical and empirical work, leading to the acceptance of the intentional binding effect as an *implicit* measure of sense of agency and the use of the Libet clock and interval estimate approaches to intentional binding to better understand the phenomenological and cognitive underpinnings of agentic experience (for a review of the two approaches, refer to chapter 1 (Cavazzana et al., 2014; Moore & Obhi, 2012).

Current research on intentional binding has depicted the sense of agency as a transient mental state that is modulated by several factors, including bottom-up, top-down, predictive, and postdictive cues (Malik et al., 2022). Bottom-up cues, such as arousal (Wen et al., 2015; Render & Jansen, 2021), emotions (Aarts et al., 2005; Christensen et al., 2019), and internal motoric cues (Tsakaris & Haggard, 2003), have been found to modulate intentional binding both prospectively (i.e., before acting), and retrospectively (i.e., after acting). Taking emotions as an example, researchers have found that negative emotional states, such as fear and anger,

can reduce intentional binding when experienced prior to acting (Christensen et al., 2019). Similarly, negative action-outcomes (i.e., actions that lead to a negative outcome), as compared to positive or neutral action-outcomes, have been found to retrospectively reduce intentional binding (Yoshie & Haggard, 2013). In terms of top-down factors, personality (Hascalovitz & Obhi, 2015), personal beliefs (Desantis et al., 2011; Lynn et al., 2014) and environmental constraints (Caspar et al., 2016, 2021; Soral et al., 2021), have all been found to prospectively modulate intentional binding. Taking personal beliefs as an example, researchers have demonstrated that beliefs about causality can increase intentional binding, while beliefs about determinism can reduce the binding effect. Lastly, theoretical work has suggested that top-down factors can modulate intentional binding retrospectively; however, empirical work to support this claim is limited (Malik et al., 2022).

Building on these foundational insights, several researchers have begun to ask more nuanced questions, particularly about the experience of agency in the dynamic social world (Khalighinejad & Haggard, 2016; Silver et al., 2020). Focusing on common social encounters, one line of research has concentrated on the effect of collaboration on the sense of agency. This work has revealed that when engaging in joint actions, people tend to experience a sense of *"we agency"* over an outcome (i.e., similar intentional binding for independent and joint actions) (Obhi & Hall, 2011; Jenkins et al., 2021), and when people are placed in leadership positions, they tend to experience a sense of *"vicarious agency"* over the actions of their follower/subordinate (i.e., similar intentional binding for self-generated outcomes and the actions of a follower) (Pfister et al., 2014). A second line of research has explored the social impacts of one's actions on the sense of agency. Echoing the research on emotional modulators

of sense of agency, this work has demonstrated that when an actor causes negative emotional vocalizations, they tend to exhibit lower intentional binding, as compared to when they generate positive emotional vocalizations (Yoshie & Haggard, 2013, 2017). Extending these routine daily encounters, a third line of work has focused on the role of *potent* social experiences, namely, the effect of adverse social events on the sense of agency. This line of work has revealed that in comparison to baseline and positive experiences (including social inclusion and powerfulness), negative experiences (including social exclusion and powerlessness) tend to trigger lower intentional binding (Obhi et al., 2012; Malik & Obhi, 2019). These findings have been taken to suggest that socio-emotional processes can powerfully shape experiences of agency.

Altogether, these early lines of research have provided critical insights into how the sense of agency is modulated within the dynamic social world. They have also hinted at the potential mechanisms that may drive changes in agentic experience (Silver et al., 2020; Villa et al., 2022). However, the extent to which social experiences affect diverse members of society has yet to be understood.

In the present chapter, we aim to bridge this gap by exploring the impact of a social experience that has been found to disproportionally marginalize certain social groups (Link & Phelan, 2001). The experience we are referring to is stigma, which is defined as a marker of devaluation which can reduce an individual from a whole person to a tainted and discounted one (Goffman, 1963). We are interested in this experience within our work, as *perceptions* of stigma have been found to negatively affect three close correlates of the sense of agency, including self-perception, voluntary actions, and psychological/mental functioning (David et al.,

2008; Haggard, 2017) Namely, in the social cognitive literature, perceptions of stigma have been found to negatively affect performance and mental well-being by threatening a core aspect of one's self-perception (Major & O'Brien, 2005; Frost, 2011). Since the sense of agency underlies many of these experiences, we predict that the perceptions of stigma can also reduce sense of agency. Drawing on recent intentional binding work, we further predict that stigma will affect the sense of agency through social-emotional mechanisms. Specifically, as compared to experiences of acceptance (a positive social experience), we predict that experiences of stigma (a negative social experience) will reduce intentional binding – as indexed by greater action-effect interval estimates.

To test these predictions, we designed two within-subject experiments. The goal of the first study was to observe the role of a particular type of stigma that has been deemed prevalent in the current socio-political climate: racial stigma (Williams, 2012; Quinn et al., 2020). This exploratory study was developed to assess racial stigma within a convenience sample. Extending this work, the second study was developed to assess racial bias, a consequence of racial stigma (Frost, 2011), amongst racial-ethnic minorities. By exploring the issues within a representative sample, we anticipate a clearer image of agentic experience amongst diverse groups.

In line with recent work, we decided to use episodic prime essays to manipulate social perceptions and the interval-estimate approach to intentional binding to measure the sense of agency (Obhi et al., 2012; Malik & Obhi, 2019). We decided to include a questionnaire about the episodic content of the manipulations (Addis et al., 2008) to gain deeper insights into the mechanisms through which social experiences affect intentional binding. Additionally, we

decided to include the Big-5 Inventory and Self-Stigma Scale, as previous research has demonstrated that individual differences revealed by these measures can affect how racial minorities experience and cope with race-based stressors such as stigma (Mak & Cheung, 2010).

2.2. Study 1: Racial stigma

2.2.1 Methods

This research study was open to both racial minorities and non-racial minorities via the McMaster Psychology Research Pool and social media. Diverse persons were able to participate in the study by reporting on experiences of stigma and acceptance related to *any* social identity feature during the experimental manipulation. However, to answer our research question, our analyses focused on the responses of those participants who reported on their racial identity. A benefit of this approach was that we, the researchers, did not have to make assumptions about whom racial identity was most salient for. Rather, participants who perceived their racial identity as a source of stigma or acceptance could indicate so.

Participants

Eighty-one participants with normal or corrected-to-normal vision, auditory and tactile acuity were recruited to the study through online advertisements. During data cleaning, data from forty-three participants were removed from the dataset. Of these, fifteen participants failed to complete the study, three participants incorrectly responded to our questions, and twenty-five participants responded to one or both manipulations with an experience that was

not about race. Data from the remaining thirty-nine participants (8 male, 4 left-handed, M_{age} = 19.6, *SD* = 1.7) were stored for further analysis (**Table 1A**).

The sample size for the study was based on participant enrollment over the school semester. Consent was obtained prior to study commencement, and participants were compensated financially or with course credit. The study protocol was approved by the McMaster Research Ethics Board (MREB).

Apparatus and Stimuli

Ontario guidelines regarding the COVID-pandemic prevented in-lab testing. As a result, the study was administered virtually by an undergraduate experimenter using Zoom, a secure video-conferencing application. To engage in the study, participants were required to use their personal computers/laptops, keyboards, trackpads/mouses, and earphones/headphones. Communication between the experimenter and participants was facilitated by the use of a webcam, mic, and the Zoom chatbot.

The study was coded using a JavaScript library known as jsPsych and hosted online using Cognition.run. The study was programmed to present all stimuli on a white background. To ensure a valid and reliable assessment of relative judgements, study questionnaires were presented in an ascending horizontal format (Maeda, 2013).

Intentional binding task

Intentional binding was assessed in the study using the interval-estimate method. The task was presented in blocks. Each block included a set of instructions, 5 practice trials, and 30 experimental trials. Each trial began with the presentation of a black fixation cross at the center of a white screen (**Figure 1B)**. Participants were instructed to focus on the cross and, at the time

of their choice, press the space bar, which would trigger an auditory tone (1000 Hz, 100 milliseconds) after a 100, 400, or 700-millisecond delay (Malik & Obhi, 2019; Obhi et al., 2012). Once the tone ended, the fixation cross was replaced by the word "Estimate." At this time, participants were invited to verbally estimate the interval of time between their keypress and the tone. The estimate was then recorded into an Excel sheet by the experimenter, and the participant was advanced to the next trial.

An important point to note about this task is that the true interval estimates were never revealed to participants. All estimates were based on participants' perceptions.

Stigma and acceptance manipulation

Participants' perceptions of stigma and acceptance were manipulated using episodic prime essays. The prompts read as follows:

> **"**Please recall a particular incident in which you felt **stigmatized**[1] (accepted) **due to** (based on) your racial identity. Specifically, think about a time where your identity **led you to be negatively evaluated as tainted or discredited** (identity was welcomed, and you were well-received). Describe this situation—what happened, how did you feel, who/what made you feel that way? In your retelling of the incident, recall the time and the place. Concentrate on the emotions and feelings associated with the incident. Provide as many details as you see fit to provide a complete picture of the incident.

[1] *The bolded text was used for the stigma prompt, while the text in parentheses was used for the acceptance prompt.*

If you feel you have not experienced **stigma** (acceptance) due to your race or ethnicity, please discuss another identity feature that led you to be **stigmatized** (accepted) in a certain context. Some examples include religious and sexual identity.

Note: Stigma refers to any physical or social attribute or sign that devalues an individual's social identity. By way of this attribute, individuals are reduced from a whole and usual person to a tainted discounted one and labelled as different, abnormal, shameful, or less desirable. "

This task was adopted into our study based on previous work, which has suggested that episodic recollection of specific events can approximate the state that was active during the initial experience. Within experimental conditions, this task is said to allow researchers to empirically assess the downstream effects of perception on cognition and behaviour (Galinsky et al., 2003, 2006).

Episodic detail questionnaire

To gain a deeper understanding of the impact of the episodic recall essays, a 6-item multiple choice questionnaire (**Figure 1C**) inquiring about the episodic content of the memory reported was included (Addis et al., 2008; Levine et al., 2008).

Questionnaires

Three surveys were included to characterize the sample and assess individual differences. The first questionnaire was a demographic survey about participants' age, ethnicity-race, gender identity, handedness, and self-identified racialized status (**Table 1A**). The second questionnaire was the big-5 personality test, which assessed five elements of personality: extraversion, neuroticism, agreeableness, openness to experience and

conscientiousness (Goldberg, 1992). The third questionnaire was the internal stigma questionnaire (Self-Stigma Scale), which assessed three dimensions of the experience: cognition, affect and behaviour. The Self-Stigma Scale was an optional test included for those who identified race-ethnicity as a salient aspect of their identity (n =32) (Mak & Cheung, 2010).

Procedure

The study was advertised online as a research project exploring the cognitive mechanisms that underlie written and motor control tasks. Participants were told that they would engage in two separate studies, interleaved in the same session, to reduce the time it took to complete the study (Malik & Obhi, 2019). Interested individuals connected with the research team via email and the McMaster psychology SONA portal. Upon confirming eligibility, which was that participants were between 18 and 65 years of age, the undergraduate researcher scheduled a 50-minute Zoom session for each participant.

At the start of the Zoom call, participants were provided with a weblink with the study and assigned a group id (either group A or B). The first task participants engaged in was intentional binding (**Figure 1A**). After completing their initial intentional binding block (pre-manipulation 1), they were directed to their first manipulation. Depending on whether they were assigned to groups *A* or *B*, they either recalled an experience of stigma or acceptance. After the manipulation, participants were presented with the episodic detail questionnaire, which further inquired about the experience recalled. This questionnaire was followed by a second session of the intentional binding block (post-manipulation 1).

To limit potential carry-over effects from the first manipulation, participants were asked to complete a filler task (a 5-minute online maze). After this task, they completed another block

of the intentional binding task (pre-manipulation 2), the remaining manipulation (manipulation 2), and a final intentional binding task (post-manipulation 2). To conclude the study, participants were directed to link where they accessed and completed a demographic questionnaire, a personality questionnaire (Big-5 Inventory) (John & Srivastava, 1999), and an internal stigma questionnaire (Self-Stigma Scale) (Mak & Cheung, 2010).

Manipulation check

Two independent coders, blind to the study hypothesis, assessed the episodic recall essays to examine whether the manipulations truly shifted social perceptions. To conduct this assessment, coders relied on a codebook with two 6-point scales (+3 to -3). The first scale was on stigma experience. On this scale, +3 represented strong acceptance content, 0 indicated no acceptance or stigma content, and -3 represented strong stigma content. The second scale assessed emotional content. On this scale, -3 represented strong negative emotional content, 0 indicated no emotional content, and +3 represented strong positive emotional content (Hauser et al., 2018; Malik & Obhi, 2019). For interpretability, coders' ratings were reverse coded before analysis.

Data Processing

Two outlier criteria were determined prior to the study. The first was a trial exclusion criterion. It was determined that action-effect interval estimates that were +/- 2.5 standard deviations from a participant's mean estimate across conditions were considered outliers and removed from the dataset (Jenkins & Obhi, 2022). About 4.2% of the data met this criterion. The second criterion was the participant exclusion criterion. If the trial exclusion criteria removed more than 20% of a participant's data, their data would be considered unusable, and

they would be removed from the dataset (Barlas et al., 2017). No participant met this exclusion criterion.

2.2.2 Results

Manipulation check

To assess the inter-rater reliability of codes, intraclass correlation coefficients (ICC) and their 95% confidence intervals were calculated. ICC estimates were based on mean-rating (k=2), consistency-agreement, and 2-way mixed effects models. Using Koo et al.'s (2016) guidelines for interpreting intraclass correlations, coders' ratings for stigma content (stigma condition: *ICC*(C,2) =0.88, *F*(37,37) = 8.64, *p*<0.01; *CI* = 0.8-0.9 and acceptance condition: stigma *ICC*(C,2) = 0.8, *F*(37,37) = 4.84, *p*<0.01; *CI* = 0.6-0.9) and emotional content (stigma condition: emotional content *ICC*(C,2) = 0.9, *F*(37,37) = 11.2, *p*<0.01; *CI* = 0.8-0.9, and acceptance condition: *ICC*(C,2) = 0.8, *F*(37,37) = 4.9, *p*<0.05; *CI* = 0.6-0.9) demonstrated excellent reliability, and provided statistical support to compute average coder-ratings, which were needed to assess differences in stigma and emotional content between conditions.

Shapiro-Wilk tests revealed non-normal distribution of the residuals for emotional content (*W*= 0.91, *p*< 0.01) and stigma content (*W*= 0.78, *p*<0.01), suggesting that a non-parametric test would be most suitable for these data. Wilcoxon ranked sum tests revealed a statistically significant difference in stigma (*V=1*, *p*<0.01, *R*= 0.87) and emotional content (*V*=0, *p*<0.01, *R*=0.88) between conditions. The stigma condition contained more stigma content and negative emotional content than the acceptance condition (**Table 1B**).

The effect of racial manipulation on action-effect interval estimates

A 2-way Repeated Measures ANOVA (factor 1: time and factor 2: condition) was used to examine the effect of racial stigma and acceptance on average action-effect interval estimates. The ANOVA revealed a significant main effect of time $F(1,38) = 5.4$, $p = 0.03$, $\eta p^2 = 4.3\text{-}03$, where participants reported significantly longer interval estimates post-manipulation ($M = 416$, $SD = 162$) as compared to pre-manipulation ($M = 395$, $SD = 160$) (**Figure 1D**). There was no effect of condition ($F(1, 38) = 0.3$, $p = 0.6$, $\eta p^2 = 6.9\text{-}04$), nor any interaction effect ($F(1, 38) = 0.5$, $p = 0.5$, $\eta p^2 = 2.6\text{-}04$) indicating no significant differences in interval estimates as a result of the condition participants were in, and no significant interaction between the condition participants were in and the time at which they completed the intentional binding task.

Self-reported episodic detail of racial manipulations

To better understand the effect of our manipulation, we planned to assess differences in episodic detail between conditions using paired sample-t-tests. Questions 3, "How personally important is this event to you now" and 5, "On average, how often do you think or talk about this event," were analyzed as planned. For questions 1, "How clearly can you visualize the event" ($W = 0.93$, $p = 0.2$), 2, "How much did your emotional state change from before recalling the event to after you recalled the event?" ($W = 0.93$, $p = 0.02$), 4, "How personally important was this event to you then?" ($W = 0.93$, $p = 0.01$), and 6, "Rate the valence of the experience (i.e., how positive or negative the experience was)" ($W = 0.9$, $p < 0.01$), we used Wilcoxon Signed-Rank tests, due to violations of normality determined by Shapiro-Wilk tests. These analyses revealed that participants reported significantly greater emotional change from before to after the event (question 2) and greater negative emotional valence (question 6) in the

stigma condition, as compared to the acceptance condition. For questions 1,3,4 and 5, there were no significant differences in episodic details between the two conditions **Table 1C.**

The effect of manipulation order, time, and condition on action-effect interval estimates

A 3-way Mixed ANOVA with two within-subject factors, condition (acceptance vs. stigma) and time (pre vs. post), and one between-subject factor, order (acceptance first vs stigma first), was conducted to examine whether the order in which manipulations were presented affected interval estimates. The analysis revealed a significant effect of time $F(1,36) = 5.7$, $p=0.02$, $\eta p^2 = 7.3\text{-}03$ and order $F(1,36)= 5.4$, $p=0.03$, $\eta p^2=1.1\text{-}01$. Participants had greater interval estimates post-manipulation (M=402, SD= 139) as compared to pre-manipulation (M=380, SD= 134). Regarding the effect of order, participants who completed the acceptance manipulation first reported greater interval estimates across the study (M=435, SD=125) as compared to those who underwent the stigma manipulation first (M=347, SD 134). We did not find an effect of condition $F(1,36) = 0.3$, $p=0.6$, $\eta p^2=1.1\text{-}03$, nor any combination of interactions: order by condition $F(1,36) = 0.3$, $p=0.6$, $\eta p^2=1\text{-}03$, order by time $F(1,36) = 2.0$, $p=0.2$, $\eta p^2=2.5\text{-}03$, condition by time $F(1,36) = 0.5$, $p=0.5$, $\eta p^2 = 4.3\text{-}04$, or order by condition by time $F(1,36) = 0.1$, $p=0.7$, $\eta p^2=1.1\text{-}04$.

The effect of time and condition on action-effect interval estimates (for manipulation 1)

To mitigate the potential carry-over effects demonstrated by the effect of order in the above analysis, we decided to focus on participants' responses from their first session (i.e., pre-, and post-manipulation 1). The data was analyzed using a 2-way Mixed ANOVA with one within-subject factor, time (pre vs. post), and one between-subject factor, condition (acceptance vs. stigma). The analysis revealed a significant main effect of condition $F(1,36) = 5.4$, $p= 0.03$, $\eta p^2 =$

1.2-01, and time $F(1,36) = 5.7$, $p = 0.02$, $\eta p^2 = 8.6\text{-}0.3$. Participants who completed the acceptance manipulation reported significantly longer interval estimates (M= 435, SD=120), as compared to those who completed the stigma manipulation (M= 339, SD=136). Moreover, as can be seen in **Figure 1E**, participants reported greater interval estimates post-manipulation (M= 402, SD=139), as compared to pre-manipulation (M= 380, SD= 134). The analysis revealed no significant interaction effect $F(1, 36) = 1.9$, $p = 0.2$, $\eta p^2 = 2.9\text{-}03$. Altogether, the revelation of a significant difference in action-effect interval estimates between groups suggests, even after focusing on only the first session of the study, led us to infer that the group-based differences represented a pre-existing difference, rather than something inherent to the study protocol.

The effect of order on baseline action-effect interval estimates

When considering the role of pre-existing differences, we speculated whether the noted discrepancy in action-effect interval estimates between groups A and B were due to a difference in extent to which people in ether group *internalized* stigma. As a powerful self-perception, we reasoned that a significant difference in internalized stigma between those assigned to acceptance first compared to stigma first, could help to explain the group-based differences in action-effect estimates. To assess internalized stigma scores across the two groups, we conducted an independent t-test, with order (stigma first and acceptance first) as the independent factor and internalized stigma scores as the dependent factor. Unlike the prior test, this analysis revealed no significant difference in internalized stigma scores between those assigned to the acceptance first condition, as compared to those assigned to the stigma first condition $t(23.9)=1.63$, $p=0.1$, suggesting that the previously noted discrepancy in action-effect

interval estimates between group A and B, cannot be explained by a discrepancy in internalized stigma scores, but rather another confounding variable.

Exploratory analyses

The effect of internalized racial stigma on baseline action-effect interval estimates

To evaluate the association between internalized stigma and sense of agency, we planned a correlation test. When screening the data for correlation assumptions, Shapiro-Wilk tests revealed non-normal distributions for baseline interval estimates (W= 0.97, p=0.5) and a normal distribution for average internalized stigma scores (W= 0.89, p<0.01), leading us to rely on a non-parametric test (Kendall rank correlation). The test revealed no significant association between variables τb =0.2, Z=1.3 p=0.2. (Refer to **Table 1D** for descriptive statistics on internalized stigma).

The effect of personality on baseline action-effect interval estimates

To test whether participants' personality traits, as measured by the Big-5 Inventory, predicted their baseline sense of agency, we conducted a simultaneous multiple regression. We selected this test as it allows us to examine the effect of each of the five personality dimensions while holding the other dimensions (predictors) constant. The dataset was screened for missing data, outliers, and regression assumptions. Although four participants met the cut-off for Cook's and Leverage values, they were included in the analysis because they did not have multiple outlier indicators. Linearity, normality, additivity, and homoscedasticity assumptions were all met. The overall regression model was not statistically significant, indicating that none of the five dimensions of personality predicted baseline interval estimates, $F(5,31) = 1.2$, p =0.34, R^2 = 0.16. (Refer to **Table 1E** for descriptive statistics on personality).

2.2.3 Discussion

This exploratory study assessed the role of racial stigma and acceptance on intentional binding, as indexed by action-effect interval estimates. We predicted that participants would report greater interval estimates after recalling experiences of racial stigma, as compared to racial acceptance or baseline conditions. We also predicted that the socio-emotional content of the prime essays would drive changes in interval estimates.

Our primary analysis revealed that participants reported greater interval estimates after episodic recall manipulations as compared to before the manipulations, regardless of whether the manipulation was in the positive or negative direction. These findings did not support our initial predictions. Instead, they led us to consider the idea that race-based experiences, regardless of their emotional content, increased action-effect interval estimates. As tempting as it is to accept this interpretation of the data, we hesitate to draw this conclusion due to several limitations in the dataset.

The first and most prominent limitation of the present study relates to the unexpected effect of manipulation order. While we counterbalanced the manipulations to mitigate the risk of order of conditions influencing temporal perception, our analysis of the order of manipulation revealed that those who completed the racial acceptance manipulation *first* (group A) reported greater interval estimates across conditions. We speculated that the effect of order may have risen due to carryover-effects. To eliminate the influence of any carry-over effects, we decided to refine our analyses to focus on participants' responses from only the first manipulation (i.e., action-interval estimates pre- and post- manipulation 1). Contrary to our prediction, analysis of the initial session suggested that group A reported greater interval

estimates as compared to group B, and as compared to pre-manipulation, greater post-manipulation scores. These findings led us to consider whether the group-based difference was driven by a pre-existing difference in the two groups. Specifically, we investigated whether the two groups differed in the extent to which they internalized stigma. This exploratory analysis on internalized stigma and baseline action-effect intervals revealed no significant association, leading us to speculate that there was another unaccounted variable confounding our results.

The second issue relates to our sample size. While our sample size is larger than that of other research studies with similar designs (Malik & Obhi, 2019; Obhi et al., 2013), simulation tests suggest that to detect a medium-sized effect (*dz* = 0.25) with 80% power, we would need a sample size of 132 participants (Lakens & Caldwell, 2019). A third and final limitation of our study was regarding our sample demographic. Our decision to allow non-racial minorities to report on stigma experiences may be seen as problematic and factually incorrect. Ongoing work suggests that stigma is enforced by systems of power and sustained by majority groups (Link & Phelan, 2001).

To remedy these concerns, we made sure that our follow-up study was sufficiently powered and focused on the experiences of racial minorities. If it is the case that race-based experiences increase action-effect interval estimates, regardless of emotional content, then we anticipate the follow-up study to replicate current results (i.e., greater interval estimates post-manipulation as compared to pre-manipulation). However, if race-based experiences reduce action-effect through socio-emotional processes, then we anticipate greater interval estimates after the negative racial experience manipulation (racial bias), as compared to the positive racial experience manipulation (racial acceptance) and baseline conditions.

2.3. Study 2: Racial bias

2.3.1 Methods

Participants

One-hundred and thirty-two individuals belonging to racial-ethnic minorities between the age of 18 and 65 were invited to participate in the study through an online research participant pool (Prolific.co). A simulation-based power-analysis determined that this sample size would detect a medium-sized effect sd_z = 0.25 in a 2 by 2 within-subject design with 80% power (Lakens & Caldwell, 2019). After removing participants who provided partial responses or failed to accurately respond to questions (n = 9), a total of 123 participants (51 male, M_{age} = 28, *SD* = 9) were included for data analysis (**Table 2A**). Consenting participants were financially compensated for their time, and the study protocol was approved by the McMaster Research Ethics Board (MREB).

Apparatus and Stimuli

This study employed similar methods to the previous one. What differed from the previous study was the way the study was administered, as well as the content of the manipulations.

Intentional binding task

The current study relied on autonomous administration, meaning participants completed the study without the support of an experimenter. This type of administration required slight modifications to how the intentional binding task was designed. Mainly, we had to modify how participants provided action-interval estimates. In line with previous work, we asked participants to report interval estimates using a slider scale, rather than providing verbal

estimates (Jenkins et al., 2021). The slider-scale had a minimum value of 0 and the maximum value of 1000, with 10 intervals between these values, each revealing an increase of 100 milliseconds **(Figure 2).**

Bias and acceptance manipulation

The initial sentence for the manipulations was modified to reflect bias and acceptance content rather than stigma and acceptance. The new prompts read as follows:

> "Recall a situation when you thought your racial identity would **lead to negative bias** (be fully accepted), and in which you **were worried about being perceived or treated unfairly** (expected to be welcomed and treated fairly) …"[23]

Procedure

The study used the same research design as before (**Figure 1C**). The only difference is that participants completed the study independently rather than over Zoom with a researcher.

Manipulation check

The two coders from the previous study were also trained to code the current dataset. For this dataset, coders examined bias and acceptance content (3 represented strong acceptance content, 0 indicated no acceptance or bias content, and -3 represented strong bias content) as well as emotional content using a similar scale to the previous study (-3 represented strong negative emotional content, 0 indicated no emotional content, and +3 represented

[2] The bolded text was used for the bias prompt, while the text in parentheses was used for the acceptance prompt.

[3] Note we only included text was different from study one. For additional details about the manipulations, refer to study one.

strong positive emotional content). All codes were reverse scored before data analysis to ensure interpretability.

Data Processing

Using the same trial exclusion criteria as the previous study (+/-2.5 standard deviations of a participant's average interval estimate across conditions), we removed 0.006% of the data.

2.3.2 Results

Manipulation check

For the bias condition, coders' ratings of bias content had good reliability *ICC*(C,2) =0.7, $p<0.01$, $F(120,120) = 3.25$, $p<0.01$ *CI*= 0.56-0.79, and moderate reliability for emotional content *ICC*(C,2) = 0.7, $F(120,120) = 3.07$, $p<0.01$; *CI* = 0.53-0.77. For the acceptance condition, coders' ratings of bias had excellent reliability *ICC*(C,2) = 0.92, $F(120, 120) = 13.1$, $p<0.01$; *CI*= 0.89-0.95, and emotional content *ICC*(C,2) = 0.84, F (120,120) = 6.24, $p<0.01$; *CI* = 0.77-0.89 had good reliability. Having established the reliability of the coders' ratings, emotional and bias content ratings were averaged for each condition, and dependent t-test assumptions were tested. Shapiro-Wilk tests revealed non-normal distributions of the residuals for emotional content ($W= 0.92$, $p< 0.01$) and bias content ($W= 0.83$, $p<0.01$). To assess the non-normal data, Wilcoxon ranked sum tests were computed. These tests revealed a statistically significant difference in bias ($V=141$, $p<0.01$, $R= 0.81$) and emotional content ($V=254$, $p<0.01$, $R=0.81$) between conditions. The bias condition contained more bias and emotional content than the acceptance condition (**Table 2B**).

Self-reported episodic detail of racial manipulations

Shapiro-Wilk tests for normality revealed that all six questions were non-normally distributed: questions 1 (W= 0.942, p<0.01), 2 (W= 0.94, p<0.01), 3 (W=0.96, p<0.01, 4 (W= 0.94, p<0.01), 5 (W=0.94, p<0.01) and 6 (W= 0.92, p<0.01). To accommodate the data, Wilcoxon Signed-Rank tests were conducted. The only significant finding for this set of questions was for question 6. Participants reported greater negative emotional valence in the bias condition **Table 2C**.

The effect of racial manipulation on action-effect interval estimates

Participants' interval estimates were averaged for each condition and entered into a two-way repeated measures ANOVA with time (pre vs post) and condition (bias vs acceptance) as within-subjects factors. The ANOVA revealed a significant main effect of time F(1, 122) = 20.1, p<0.01, ηp^2 = 1.3-02*,* no significant effect of condition *F(1,122) = 0.01, p=0.93,* ηp^2 *= 9.8 e-06* and no significant interactions *F(1,122) = 0.04, p=0.85,* ηp^2 *= 2.7 e-05*. Regarding the significant main effect of time, participants reported greater interval estimates post-manipulation (M= 406, SD =148) as compared to pre-manipulation (M= 372, SD =152) (**Figure 2B)**.

The effect of manipulation order on action-effect interval estimates

A mixed ANOVA with two within-subject factors, condition (acceptance vs bias) and time (pre vs post), and one between-subject factor, order (acceptance first vs stigma first), was used to examine whether there was a systematic difference in interval estimates due to the order of manipulations. The analysis revealed a significant effect of time F(1,120) = 19.5, *p< 0.01 ,* ηp^2*= 1.2 e-02,* a 2-way condition by order interaction F(1,120) = 9.5, *p< 0.01 ,* ηp^2 *= 1.1 e-02,* and 3-way time by condition by order interaction F(1,120) = 4.6, p<0.05*,* ηp^2 *=3 e-03.*

The 3-way interaction was decomposed into two 2 repeated measures ANOVAs with condition and time as between subject factors, the first such analysis on the subset of participants who completed the bias manipulation first and the second analysis on participants who completed the acceptance manipulation first. Simple tests on the acceptance first sample revealed a significant effect of time $F(1,60) = 7.7$, $p<0.01$, $\eta p^2 = 1.1$ e-02 (pre-manipulation M=383, SD=141, post-manipulation M=411, SD= 135), but no significant effect of condition $F(1,60) = 3.3$, $p=0.07$, $\eta p^2 = 8.0$ e-03 or interaction $F(1,60) = 1.1$, $p=0.3$, $\eta p^2 = 1.0$ e-03. Simple tests on the bias first sample revealed a significant effect of time $F(1,60) = 12.3$, $p<0.01$, $\eta p^2 = 1.2$ e-02 (pre-manipulation M=359, SD=152, post-manipulation M=391, SD= 143) and condition $F(1,60) = 6.4$, $p<0.05$, $\eta p^2 = 1.4$ e-02 (acceptance manipulation M=392, SD=147, bias manipulation M=358, SD= 148), but no interaction effect $F(1,60) = 3.8$, $p=0.06$, $\eta p^2 = 5.0$ e-03.

The effect of manipulation on interval estimates in Session 1

Considering the order effect, we decided to focus on participants' responses to session 1. After splitting the data, so that only the responses for the participants' first session were included, we entered the data into a Mixed ANOVA with 1 within-subject factor, time (pre- vs post), and 1 between-subject factor, condition (acceptance vs bias). The analysis revealed a significant effect of time $F(1,121)=13.8$, $p<01$, $\eta p^2 = 3.1$ e-02. Participants, regardless of their condition, reported significantly greater interval estimates post-manipulation (Pre: M=346, SD=148; Post: M=399, SD=149) (**Figure 2C**).

Exploratory analyses

The effect of internalized stigma on action-effect interval estimates

Shapiro-Wilk tests revealed non-normal distributions for both baseline interval estimates (W= 0.98, p=0.04) and mean internalized stigma scores (W= 0.9, p<0.01), leading us to rely on a non-parametric test (Kendall rank correlation). The test revealed a non-significant association between variables τb=-0.06, Z=-0.9, p= 0.4. (Refer to **Table 2D** for descriptive statistics on internalized stigma).

The effect of personality on action-effect interval estimates

A simultaneous multiple regression was planned to assess the effect of personality on intentional binding. Four participants were removed from the analysis for meeting at least 2 of 3 outlier indicators (Mahalbolis, Cook's and/or Leverage values). Linearity, normality, additivity, and homoscedasticity assumptions were all met. The overall regression model was not statistically significant, indicating the five dimensions of personality did not predict baseline interval estimates, F(5,113) = 0.2, p=0.97, R^2 = -0.04, nor did the individual personality dimensions (p>05). (Refer to **Table 2E** for descriptive statistics on personality).

2.3.3 Discussion

This study examined the role of racial bias and acceptance on intentional binding in racial minorities. Drawing on the earlier study and extant work, we predicted one of two outcomes:

1. That racial bias would mitigate the sense of agency, as indexed by greater action-effect interval estimates post-stigma manipulation, as compared to post-acceptance and baseline conditions and
2. That race-based experiences would mitigate the sense of agency, as indexed by greater action-effect interval estimates post-manipulation.

This study provided support for the latter prediction. Participants reported greater interval estimates post-manipulation. This was the case, even though participants and experimental coders reported different emotional content across the two experiences. Namely, experiences of bias were more negatively valenced.

Given the limitations in the previous study, we decided to assess the effect of manipulation order once more. This analysis revealed that participants who underwent acceptance first (group A) reported greater interval estimates post-manipulation (in line with our general analyses). For participants who underwent bias first (group B), we found greater interval estimates post-manipulation as well as greater interval estimates when engaging in the second session of the study (acceptance manipulation). We attributed the latter finding to carryover effects, as an analysis of only the first session of the data revealed an effect of time (i.e., greater interval estimates post-manipulation). That said, it is curious why this effect was only seen in the bias first condition and not those who underwent the acceptance condition first. We speculate that the bias condition may have been more mentally taxing, and thereby the filler task was not sufficient in mitigating its effect on baseline interval estimates in the second session.

2.4. General Discussion

The goal of the present work was to gain a deeper understanding of the social modulators of the sense of agency. Drawing on emerging trends in the literature, we predicted that personally significant negative social experiences, such as racial stigma and bias, would lead to lower intentional binding (indexed by greater action-effect intervals) when compared to a positive experience, such as racial acceptance. We tested this prediction across two

experiments. Across the studies, we found that the recollection of both positive and negative race-based experiences was associated with reduced binding (i.e., greater post-manipulation interval estimates). We found this trend, despite both coder-reported and participant-reported differences in emotional valence content across the two conditions. Given the proposed link between intentional binding and sense of agency, we interpret these results to suggest that race-based social experiences, regardless of their emotional properties, can reduce the sense of agency.

Interpreting our main analysis

Reflecting on both our work and the cognitive literature on social modulators of intentional binding, we question whether the observed effects are attributable to changes in the perception of the individual or entity in control (De Vignemont & Fourneret, 2004). Our experimental manipulations required participants to reflect on a time when they perceived being viewed/evaluated in a particular manner. Regardless of the emotional valence of the manipulations, participants were engaged in a task where they perceived *other* people to affect their experiences. This fundamental perception, irrespective of its truth, not only focuses on social others but also casts them as entities responsible for the participants' experiences. Considering the inter-related nature of the self-other, as well as recent evidence that deterministic beliefs (Lynn et al., 2014) reduce the sense of agency, while personal causal beliefs are linked with a strong sense of agency (Desantis et al., 2011), we propose that the reduction in the sense of agency in our studies, suggested by our intentional binding data, may have been due to the attribution of control to another person. To make conclusions about the mechanisms that allow social experiences to affect sense of agency, more work is required. To

investigate the proposed role of self-other-attention, we suggest future work should investigate the role of attention/focus across social contexts.

A second interpretation can be found when drawing on the social cognitive literature on race and stigma. Drawing on this literature, we query here that it may be the fact that the race-based manipulations led people to attend to being a "racialized other", which negatively affected their sense of agency. In other words, the simple awareness of belonging to a stigmatized group, regardless of how people were treated, was sufficient to reduce people's sense of agency. Evidence for this explanation comes from a growing literature on social identity threat, which postulates that as members of stigmatized groups, racialized persons are perpetually aware and concerned with the possibility of being viewed based on their group-membership (Steele et al., 2002; Major & Schmader, 2018). This is especially the case in environment where stereotypes about one's in-group may be present. Within this field of study, awareness of threat is said to affect self-processes (Major & O'Brien, 2005), such as self-image and even personal control, that is the belief of control over one's life outcomes (Cadinu et al., 2006). To examine whether the simple awareness of one's stigmatized identity is sufficient to trigger changes in sense of agency, future work should consider examining what activating different as aspects of one's identity can do to one's agency.

Interpreting our exploratory analyses

To evaluate the mechanisms through which race-based experiences affect the sense of agency, we assessed the episodic content of our manipulations. Besides emotions, which deviated across manipulations, all other episodic details were similar. We speculate that the comparable levels of episodic detail, including how intently people visualized the events, and

the relevance of the event at the time of its occurrence, may have led to the comparable trends in action-effect interval estimates across conditions.

To understand how the sense of agency is modulated in the minds of diverse individuals, we examined the role of personality and internalized stigma on the sense of agency. We indexed the sense of agency using baseline action-effect interval estimates. Across the studies, we found insignificant effects of both factors. We took these findings to suggest that personality and internalized stigma do not affect baseline levels of sense of agency. Future work may want to conduct mediation and moderation analyses to assess whether either of these factors affect the way *stigma* (and other race-based experiences) influence the sense of agency.

Limitations

Our research interpretations are to be taken with caution due to two limitations. The first limitation is in regard to the unforeseen effect of manipulation order. Because we observed the order effect in both experiments, we cannot rule out that order contaminated our results and may have influenced the effects we found (and did not find). Due to the early nature of our work, and the field, it is important to replicate our work before any strong conclusions can be made. To mitigate carryover effects, we suggest that future researchers consider using a between-subjects design rather than within-subjects when assessing the effect of two or more social experiences. Further, we suggest that in addition to the internalized stigma scale, future work should also include a baseline measure of stigma perception, such as the perceived stigma questionnaire (Lawrence et al., 2006), to assess individual factors that could affect the results.

The second limitation is in regard to our research methodology. Our research interpretations are contingent upon the assumption that intentional binding and, subsequently, action-effect intervals are appropriate measures of sense of agency. Despite decades of work suggesting this is the case (Cavazzana et al., 2014; Haggard, 2017), there are still researchers who argue against this, stating that intentional binding may simply demonstrate the unity of perception (Moore & Obhi, 2012; Suzuki et al., 2019) and causality (Buehner, 2012). Additionally, intentional binding has traditionally been assessed under strict experimental conditions. While the COVID-19 pandemic has pushed researchers to use this task online (Scott et al., 2022), we are only aware of the validation of the Libet clock approach (Galang et al., 2021). As we continue to rely on online research, validation of the interval estimate approach will allow us greater confidence in the present work and emerging insights in the literature.

Beyond these two limitations, one may argue that the observed increases in action-effect interval estimates post-manipulation may have been due to the fact that participants engaged in a mentally taxing reflective exercise rather than the social contents of the manipulations. This argument is based on emerging research that suggests that increased mental effort can reduce intentional binding (Howard et al., 2016). While we cannot *conclusively* rule out this assertion, as we did not include a control study or condition where we studied the effect of a neutral manipulation on action-effect outcomes, we can provide some indirect evidence against this claim. One line of evidence comes from previous work that has examined the role of adverse and positive social experiences using an episodic recall prime. As noted previously, this work has revealed that negative social experiences, compared to positive social experiences, reduce intentional binding (Obhi et al., 2013; Malik & Obhi, 2019).

Additional evidence can be drawn from research on depressive experiences on the sense of agency. When comparing the impact of a depressive memory, manipulated through an episodic prime, to a neutral memory (i.e., a description of the previous day), researchers have demonstrated that depressive memories lead to greater action-effect interval estimates (Obhi et al., 2012). Together, these lines of research suggest that the changes in action-effect interval estimates in our studies were not simply due to the mental effort that episodic prime tasks promote. Rather, there was something about the content of the manipulations that drove these changes. To confidently conclude this assertion, future researchers should replicate our work with a neutral control condition.

Conclusions and future steps

By studying the role of race-based experiences amongst a convenience sample and representative group, our work provided insight into how the sense of agency is modulated in distinct social encounters amongst diverse social groups. To extend our work, we suggest that future researchers continue to assess the role of different social experiences amongst diverse social groups. For strong, theoretically motivated work, we recommend consulting social psychological research on stigma, race, and identity threat models. By bringing together insights from both social psychology and cognitive sciences, we anticipate a more nuanced and in-depth understanding of the experience of human agency.

Chapter 3: Exploring the role of racial bias expectations on intentional binding

Prelude

This chapter was written to be submitted to either Consciousness and Cognition or Frontiers of Consciousness. These journals focus on many self-consciousness-related experiences, including the sense of agency; however, there isn't as much of a focus on social-cognitive research. Taking to account the knowledge and interest of these readers, I included an overview of the neurocognitive research on intentional binding and social cognitive work on social/racial bias expectations.

3.1 General introduction

Social cognitive research has long established that stigmatized groups, i.e., individuals who are tainted and discounted by society (Goffman, 1963), demonstrate worse psychological and performance outcomes as compared to non-stigmatized groups (Hagedoorn et al., 2000; Thompson & Sekaquaptewa, 2002; Mckay et al., 2008; Davey et al., 2014). However, it has not been until the last few decades that researchers have better understood the psychological mechanisms that may lead to differential outcomes (Steele et al., 2002; Major & O'Brien, 2005; Moore & Tangney, 2017; Turn et al., 2017). Ongoing research has revealed that an important psychological mechanism that drives negative experiences amongst stigmatized groups is a situationally triggered expectation known as social identity threat (SIT) (Kaiser et al., 2006; Holmes et al., 2016; Kunstman & Fitzpatrick, 2018). SIT is defined as the expectation of

differential evaluation based on one's membership in a devalued social group. It has been conceptualized as a *situationally triggered* expectation, as these expectations emerge through environmental and internal cues that bring to awareness cultural biases about one's in-group (Major et al., 2018). When these expectations are triggered, researchers have found that stigmatized persons tend to demonstrate greater working memory load (Schmader & Johns, 2003; Rydell et al., 2009) and hypervigilance (Schmader, 2010), as well as a range of voluntary actions to manage emotional distress linked with this expectation (Inzlicht & Kang, 2010), and all these responses are found to have downstream effects on wellbeing and performance. Regarding the mechanisms of action, SIT suggests that these situationally triggered expectations affect a wide range of outcomes due to their impact on self-related processes (Major et al., 2005). This line of reasoning is based on a large literature on self-related processing, which has demonstrated that people are fundamentally driven to maintain a positive self-view (Crocker & Luhtanen, 1990; Branscombe & Wann, 1994; Mann et al., 2004; Vignoles et al., 2006; Dunn et al., 2009), that this self-view is necessary for wellbeing and normative functioning (Wright, 2000, Kim et al., 2012), and that it can be modulated by internal (Humphreys & Sui, 2015; Weiss et al., 2011) and social factors (Weiss et al., 2011). Extending this line of work, empirical research on SIT has revealed that expectations of differential evaluation threaten people's desire for a positive self-view, especially the aspect of the self that is related to membership in a meaningful social group, i.e., social identity (Major et al., 2005), in addition to other self-related processes such as collective self-esteem (Scheepers et al., 2009), and personal control (Ellemers et al., 2001).

The role of self-related processes in explaining the impact of situationally triggered expectations on stigmatized groups has provided researchers with substantial direction as to where to invest efforts to better understand the subjective processes that shape the experiences of stigmatized persons. However, as an early literature, many gaps remain. For example, researchers have yet to understand the exact association between these expectations, self-related experiences, and psychological and behavioural outcomes. To start to bridge this gap, this paper focuses on understanding the impact of expectations of differential evaluation on a self-related process that underlies many factors that SIT impairs, including self-consciousness (David et al., 2008), action/performance (Wen et al., 2015) and mental well-being (Moore, 2016). The experience of interest is commonly known as the sense of agency. We intend to investigate the sense of agency using a novel measure used in the neurocognitive literature, i.e., intentional binding, as this tool claims to assess the self-related process implicitly (Moore, 2016). Given the multifaceted nature of self-related experiences (Gallagher, 2012), this tool will help to provide insights into a particular aspect of self-related processes that have yet to be explored in the literature (Gilboa-Schechtman et al., 2020). Namely, this task aims to capture the sense of agency at a pre-reflective level, i.e., the basic awareness of the self, which is related to albeit distinct level of experience, to the commonly studied reflective level, i.e., the higher-order and conscious experience of self (Moore, 2016).

Neurocognitive research: Sense of agency and prospective modulators of intentional binding

The sense of agency is defined as the experience of control over one's actions and, through them, their outcomes in the world (Haggard, 2017). For healthy people, the pre-reflective, or low-level awareness of agency, characterizes voluntary actions, allowing them to

seamlessly execute goal-directed actions (Moore, 2016). That said, recent research has suggested that the sense of agency is not always experienced at the same intensity. Instead, there are many cues that prospectively modulate the experience at a given time. Theoretical work has suggested that predictive cues (Frith et al., 2000), such as internal sensorimotor predictions based on efference copy of motor commands, as well as cognitive expectations based on priming (Synofzik et al., 2013), can shape agentic experience across groups. Experimental work has provided evidence of the role of prospective modulators of agentic experience, through a phenomenon known as intentional binding. Intentional binding refers to the perceived reduction of time between a voluntary/goal-directed action and its outcome, as compared to the perceived time of voluntary action alone or a sensory event alone, as well as the time between an involuntary behaviour and outcome – which is perceived as longer in time (Haggard et al., 2002). The differences in temporal perception across various types of actions have been said to represent the way the brain and mind allow people to experience pre-reflective sense of agency (Haggard & Tsakaris, 2003). General acceptance of this tool as an implicit measure of sense of agency, has led to its use to understand the role of various prospective modulators (Malik et al., 2022). Recent evidence includes the role of arousal, emotional valence, and even psycho-social factors, as experiences that *prime* sense of agency. Namely, researchers have found that high-arousal, as compared to low-arousal, as measured by Galvanic skin response, to different coloured shapes during the intentional binding task (black versus red), was linked with greater intentional binding, as compared to low-arousal conditions (Wen et al., 2015). As it relates to emotional valence, researchers have found that positive and negative emotions, prior to voluntary actions, can modulate people's sense of agency, such that

positive emotions increase intentional binding, interpreted as greater agency (Aarts et al., 2005). In contrast, negative moods reduce intentional binding, interpreted as less agency (Christensen et al., 2019). Extending these lines of work, researchers have found that psycho-social experiences, manipulated using an episodic recall task, i.e., a task that prompts people to recall an event by drawing on episodic details of the event (Gallagher et al., 2003), can shape the sense of agency. Particularly, compared to positive psycho-social experiences, including powerfulness and social inclusion, experiences of social exclusion and powerlessness have been found to reduce intentional binding, as indexed by greater action-outcome estimates (Obhi et al., 2012; Malik & Obhi, 2019).

Ongoing research on prospective modulators of intentional binding has provided insights into important factors that modulate pre-reflective self-experience. Like social cognitive work on SIT, this work has also started to elucidate the potential self-related processes that may lead diverse groups to exhibit adverse outcomes. This argument is based on emerging research focused on the role of psycho-social modulators. Specifically, researchers who have studied the role of social exclusion on the sense of agency proposed that the reductions in sense of agency may help to explain how and why people who are ostracized may exhibit worse behavioural regulation and performance (Malik et al., 2019). Similarly, the findings on powerlessness were used to consider the role of sense of agency in high and low-power settings, whereby members of different social groups navigate these settings quite distinctly (Obhi et al., 2012). That said, to date, these implications are speculatory, and more research is required to better understand the role of a pre-reflective sense of agency in the lives of diverse social groups and their impact on well-being and performance.

Current work: Extending social cognitive and neurocognitive work

Drawing inspiration from the social cognitive work on SIT and self-related processing and neurocognitive work on modulators of intentional binding, this chapter aims to extend both lines of research by assessing the hypothesized link between SIT and the pre-reflective sense of agency. We are primarily interested in assessing the role of expectations of social bias on the sense of agency amongst stigmatized groups. We aim to assess this by adopting neurocognitive research methods, which include an episodic recall task to manipulate psycho-social expectations and intentional binding to measure the sense of agency. For more in-depth insights, we also plan to include several exploratory measures, including self-reported identity threat, expectation confirmation (i.e., interpretation of reported event) and self-monitoring, i.e., the extent to which people monitor self-representation in response to social cues (Snyder, 1987), which is an important individual factor that has been shown to affect stigmatized groups' experiences interest (Fong, 1997; Burgess & Molina, 2018; Roland-Jenkins, 2019). Furthermore, for insights into the psychological factors that our manipulation prompts, we include an episodic detail questionnaire (Addis et al., 2008).

In terms of our population of interest, given the number of stigmatized groups in society and the novelty of this research program, we decided to focus on a particular type of bias amongst a particular social group. Given the current socio-political climate, as well as recent research which has suggested a lack of research on the subjective experiences of this group in the cognitive sciences, we plan to focus on expectations of racial bias amongst racial-ethnic minorities (henceforth racial minorities) (Roberts et al., 2020). With this group in mind, we predict that expectations of racial bias will reduce the sense of agency of racial minorities, as

indexed by lower action-effect interval estimates post-manipulation. Additionally, we predict participants whose expectation of racial bias was subjectively confirmed and those whose identity was threatened during the manipulated interaction, as reported by self-report measures, will report greater interval estimates post-manipulation, as compared to those who did not perceive their expectation to have been confirmed or their identity to have been threatened. Finally, we do not have any predictions for the episodic detail and self-monitoring questionnaires. For these measures, we are simply interested in assessing whether these factors affect how racial bias expectations shape the experience of agency amongst racial minorities.

3.2 The role of racial bias expectation on intentional binding

Within this research program, we plan to test our predictions in a context where racial biases are currently prevalent (Experiment 3A: North American sample) (Clark et al., 2014; Escayg et al., 2017; Park et al., 2022; Pollock et al., 2022), and then replicate the study in a broader context (Experiment 3B: International sample). Our rationale for extending this work beyond the North American population comes from emerging research establishing a trend in international hate and discrimination against specific racial-ethnic minority groups (Chae et al., 2021; Chan & Montt Strabucchi, 2020; Chen & Wu, 2021; Elias et al., 2021; Guo & Guo, 2021; Keum & Miller, 2018; Levin, 2022). By replicating our work in different samples, we can persuasively argue that our results reflect an accurate and robust effect in the world.

3.2.1 Experiment 3A (North American sample)

3.2.1.1 Methods

Participants

To determine the sample size necessary for detecting a significant effect of manipulation, we conducted an a priori power analysis (effect size = d_z = 0.25, alpha = 0.05, power = 0.9) using GPower (Faul et al., 2007; 2009). This analysis revealed that a sample size of 44 participants was required to test our study hypothesis.

We drew this sample from the online community using a participant recruitment platform called Prolific (www.prolific.co). This tool allowed us to invite Prolific users who met eligibility criteria: 1. Age (18 to 65 years), 2. Racial-ethnic identity (African, Black/African American, Caribbean, East Asian, Latino/Hispanic, Middle Eastern, Mixed, Native American, or Alaskan Native and South Asian), and 3. A resident of Canada or America.

Of the 25,308 eligible participants, 47 provided consent, and 45 participants (25 males, 5 left-handed, 18-58 years old, M_{age} = 29, SD = 10) completed the online study for financial compensation (**Table 3A**). Ethical approval was obtained from McMaster University's Research Ethics Board (Project ID: 4889).

Apparatus and Stimuli

The experiment was coded using JsPsych (v7.2.1), a JavaScript plugin for creating browser-compatible behavioural experiments (de Leeuw, 2015), and hosted online using Cognition, a customized server for jsPsych studies. All study materials were presented on a white background, and the transition time between web pages was set to 50 milliseconds. For the intentional binding task, auditory stimuli were programmed to a set volume, pitch (1000 Hz)

and duration (100 milliseconds) and presented 100, 400 or 700 milliseconds after a participant's voluntary keypress. To minimize predictability, delays were pseudorandomized. Action-effect intervals were reported using a slider scale, with a minimum value of 0 and a maximum value of 1000. There were ten intervals between the minimum and maximum value, each interval revealing an increase of 100 milliseconds.

Recognizing the impact of environmental factors on performance, participants were asked to complete the study alone and in a quiet room. Participants were also asked to wear earphones/headphones, particularly for the intentional binding task.

Procedure

The study was advertised as a research project looking to better understand the cognitive mechanisms that underlie written and motor control tasks. Participants were told they would take part in two separate studies: one on creative writing and one on motor control. In line with the foil story, the session was said to begin with the motor control study, then at the halfway point, the creative writing study, followed by the rest of the motor control study and a few questionnaires. In actuality, participants began the session with an initial block of the intentional binding task (pre-manipulation), followed by an episodic manipulation task (manipulation) and post-manipulation questionnaire, a second block of the intentional binding task (post-manipulation), and our exploratory questionnaires (**Figure 3A**).

Intentional binding task

Each block of the intentional binding task included five practice trials and 30 experimental trials. The practice trials were used to orient participants and data from these trials were not included in our analyses. These trials included step-by-step guidance on how to

complete the task and provided participants with a frame of reference to base their estimates on. The frame of reference we used was the duration of an eye-blink, which is about 300-400 milliseconds. At the end of the practice trials, participants were informed that the coming trials would be stored and used for evaluation. They were asked to proceed to the experimental trials only when they were comfortable to do so.

Each experimental trial began with the presentation of a fixation cross centred on a white screen. At the time of their choice, participants were instructed to press down on the spacebar, using their index finger. The keypress pseudo-randomly generated a tone after either 100, 400 or 700 milliseconds (Obhi et al., 2012; Malik et al., 2019), which then generated a slider scale to appear. Using the slider scale, participants could indicate their estimate of the action-outcome interval (i.e., delay) (**Figure 3B)**. After inputting their response, participants selected the "Next" button on the screen to proceed to the subsequent trial.

Episodic recall manipulation

The episodic manipulation task was used to prompt people to remember a time when they expected to be met with racial bias. By recalling the episodic detail of a consolidated memory, in our case, an experience in which a participant thought they would be met with bias, the task is said to approximate the initial experience of the event, and reconstruction of these memories can have powerful downstream effects on cognition and behaviour and important to our study, sense of agency (Galinsky et al., 2003; 2006). To ensure participants truly reflected on this experience, we asked them to recall the time and place of the event, concentrate on the emotions and feelings associated with the incident and consider what they perceived caused those feelings, and then summarize these reflections into an open textbox.

Episodic detail self-report

Following the manipulation, participants were asked to complete a brief questionnaire (6 questions) about the vividness of the experience, the emotional intensity related to the experience, the valence associated with it, as well as how often they discussed the event (**Figure 3C**). Drawing on episodic memory work by Addis et al., 2008, we believe that this questionnaire will allow us further insight into the event recalled, as well as to explore the types of episodic details that may drive changes to agentic experience.

Exploratory measures

At the end of the study, participants were asked to complete a demographic questionnaire, the self-monitoring questionnaire (Snyder, 1974) and two follow-up questions about the episodic manipulation (1. whether the event threatened participants identity and 2. whether participants' expectation of bias was confirmed through their experience). The questionnaires and follow-up questions were included to explore the role of post-event interpretation and self-experience on the way racial bias expectation modulates sense of agency.

Manipulation Check

To confirm successful interpretation and completion of the episodic recall manipulation, two independent coders blind to the study hypothesis rated the level of bias-related and emotional (positive and negative) content of participants' responses using a 7-point Likert scale (0 = none/not at all, and 6 = a lot/very much) (Galinksy et al., 2003). We included emotional content, as previous work has indicated a powerful role of emotions when recalling socially and

personally relevant events (Obhi et al., 2013; Malik & Obhi, 2019). Coders' data was intended to be summarized using descriptive statistics.

Data processing

In line with best research practices, outlier and participant exclusion criteria were defined prior to study implementation (Neves & Amaral, 2020). For action-effect interval estimates, the outlier exclusion criterion was based on earlier work with a similar research design (Malik & Obhi, 2019). Following this work, we decided that action-effect interval estimates that were more than 2.5 standard deviations from a participant's mean interval estimate for a given condition would be considered outliers and removed from the dataset. Additionally, for parametric tests, we decided that average action-effect interval estimates that exceeded the typical distribution pattern (Q1 - 3*IQR and Q3+3*IQR) would be labelled as "extreme outliers" (Dawson, 2011) and removed from the analysis.

Participant exclusion was established by two criteria. The first criterion was related to the action-effect interval estimate outlier exclusion. Guided by previous intentional binding research (Barlas et al., 2017; 2018), we decided that if outlier exclusion removed more than 20% of a participant's action-effect interval estimate data, the person's data would be removed from the dataset. The second criterion was related to the expectation manipulation. We decided that participants who did not respond to the manipulation with an experience where they expected to be met with racial bias, or if their response to the manipulation was not appropriately stored, the participant's data would be removed from further analysis. Note, that the relevance of manipulation content was determined by the two independent coders who

examined the data for bias-related and emotional content (more details can be found about this in the methods and result section of Experiment 3C).

3.2.1.2 Results

During data processing, we removed 0.005% of action-effect interval estimates for meeting outlier exclusion criteria. Regarding participant exclusion criteria, we removed one participant for meeting the second exclusion criterion. Data from the remaining 44 participants was stored for analysis.

Action-effect interval estimates pre- and post- bias expectation manipulation

To assess whether participants reported greater action-effect interval estimates post-manipulation, as compared to baseline, we computed a one-tailed paired t-test on average action-effect interval estimates.

We prepared the data for this analysis by calculating average action-effect interval estimates for each participant under each condition (pre- and post-manipulation). Notably, average scores were collapsed across three the intervals (100, 400 and 700 milliseconds). In line with our prediction, the test revealed significantly greater action-effect interval estimates post-manipulation condition (M= 409.6, SD =145) as compared to the pre-manipulation condition (M= 336.9, SD =123), $t(1,42)= -3.3$, $p<0.01$, d = 0.5 (**Figure 3D**).

Episodic content of bias expectation manipulation

To gain a deeper understanding of the content of the manipulation, we summarized the six self-reported episodic detail questions using descriptive statistics. Specifically, we focused

on examining the central tendency of the data (mean) and the dispersion of the data relative to the mean (standard deviation).

We computed these statistics by transforming the categorical data into numerical data. For clarity of interpretation, higher values were attributed to greater episodic details (example, Question 1: “1. Vague memory. No recollection” = 1, and “6. Extremely clear as if it is happening now” = 6).

The descriptive analysis revealed that participants were able to clearly visualize the event (*M*= 4.84, *SD* = 0.86) and that they found the event personally relevant at the time of the event (*M*=4.61, SD = 1.47) but less so at present (*M*=3.05, SD = 1.41) (**Table 3C**). In terms of participants feelings, they reported some change in emotional content before, compared to after the event (*M*=3.36, *SD* = 1.38). Regarding the frequency in which participants think about this event, participants reported relatively low (*M* = 2.07, SD = 1.4). It is important to clarify 2.07 as a low number, as a two on the scale corresponded with “about once per year”. Lastly, on average, participants indicated neutral valence with the experience (*M*=2.96, SD = 1.54). This understanding is based on the fact that a value of 6 was related to “positive valence,” and a value of 1 corresponded to “negative valence.”

Manipulation check

Descriptive statistics were used to examine the extent to which participants a) discussed an experience related to racial bias and b) shared positive or negative emotions about the event.

Before we could conduct these statistics, it was important to establish inter-rater reliability between coders' responses. We did this by calculating intraclass correlation

coefficients (ICC), and their 95% confidence intervals were calculated. ICC estimates were based on mean rating (k=2), consistency agreement, and 2-way mixed effects models. Using Koo et al., 2016's guidelines for interpreting intraclass correlations, coders ratings for bias-related content (ICC(C,2) =0.8, F (43.43) = 4.87, p<0.01; C1 = 0.62-0.89), positive content (ICC(C,2) = 0.94, F (43,43) = 15.4, p<0.01; CI = 0.88-0.97) and negative content (ICC(C,2) = 0.86, F (43,43) = 6.85, p<0.01; CI = 0.73-0.92) demonstrated good reliability, and provided statistical support to compute average coder-ratings and compute descriptive statistics about bias and emotional-related content.

Using average coder-ratings for each area of interest, the descriptive statistics revealed moderate levels of bias content (Mean = 3.84, SD = 1.34) and negative emotions (Mean = 2.82, SD = 1.32) and little positive content (Mean = 0.81, SD = 1.23) for the manipulation (**Table 3C**).

3.2.1.3 Discussion

This initial study aimed to examine whether expectations of bias affect sense of agency in a group of people that research has indicated are subject to powerful biases (racial-ethnic minorities) in a context where such biases are most prevalent (North America). We measured changes in sense of agency by comparing action-effect interval estimates from an initial block of the intentional binding task (pre-manipulation), with average action-effect interval estimates from a block of the intentional binding task after an episodic manipulation of participants' perception of bias expectation experience (post-manipulation). In line with our prediction, our analysis revealed greater action-effect interval estimates after the bias expectation manipulation.

Descriptive analyses of the manipulation's episodic content revealed that participants were generally able to visualize the recalled event with clarity, and that they deemed the recalled events as personally relevant when they occurred. These results were in line with what we would expect for an event that is related to an important aspect of one's social identity. What came as a surprise was that participants reported a fairly neutral position regarding the event's relevance at the present time, the level of change in participant emotions as a result of the event, and the emotional valence of the experience. As a memorable experience related to one's social identity, we expected participants to have reported the event as more personally relevant even at the present time. Regarding emotional change and valence, we expected a stronger change in emotions and more negative valence. This expectation was based on previous intentional binding work which indicated that recalling adverse social experiences, such as social exclusion (Malik & Obhi, 2019) and powerlessness (Obhi et al., 2012), not only reduced intentional binding (indexed by greater action-effect interval estimates post-manipulation, as compared to baseline, and positive social experience), but that these adverse social experiences had significantly more negative valence (as compared to the positive social experience).

Echoing the self-report response, descriptive analyses from the manipulation checks further revealed moderate levels of negative emotions and limited positive emotions. Distinct from the previous analysis, but important to note, is the moderate level of bias-related content. The experiences reported included relatively less bias-related details.

Altogether, these preliminary results indicated that racial bias expectation may affect sense of agency in a North American sample. It also shed light on the types of episodic details

relevant for the change in agentic experience. However, to ensure confidence in our results, and to evaluate the generalizability of these results, we replicated this study in an international setting. The decision to replicate the study brought the possibility of conducting exploratory analyses on a larger dataset (joint dataset) with more statistical power. Thus, we decided to explore our primary question in the same way we did in the present study and the exploratory questions with the joint dataset.

3.2.2 Experiment 3B (International sample)

3.2.2.1 Methods

Like the previous study, Prolific users were invited to partake in the study, if they had indicated they were between the ages of 18 and 65 years and identified as a member of a racial-ethnic minority group. In contrast to the earlier study, no geographic restrictions were placed on the sample. Participants from all over the globe were welcome to partake in the study.

Of the 37,585 eligible participants. 61 participants indicated interest, and 44 participants (14 males, 1 left-handed, 19-34 years old, M_{age} = 24.52, SD = 4.22) completed the study for monetary compensation (**Table 3A**).

The apparatus and stimuli, procedure, manipulation check, and data cleaning process were identical to experiment 3A.

3.2.2.2 Results

We removed 0.003% of the action-effect interval estimate data, as these points were "extreme outliers". We also removed two participants for failing to report an experience where

they expected to be met with bias (criteria 2). In sum, data from 42 participants was included for further analysis.

Action-effect interval estimates pre- and post- bias expectation manipulation

For each participant, mean action-effect interval estimates for both pre- and post-manipulation blocks. These estimates were then entered into a one-tailed paired t-test, which established that participants reported greater action-effect interval estimates post-manipulation (*M*= 433, *SD* = 174.6) as compared to the pre-manipulation (*M*= 373.6, *SD* = 179.3), $t(1,41) = -2.8$, $p<0.01$, $d = 0.4$ **(Figure 3E).**

Episodic content of bias expectation manipulation

Categorical responses were transformed to a 6-point numerical scale as the previous study. Mean and standard deviations were calculated for each question and inputted into **Table 3D.**

Manipulation check

Intraclass correlations (ICC) and their 95% confidence intervals for coders bias-related (ICC(C,2) =0.8, F (41,41) = 4.91, p<0.01; CI = 0.6-0.9), negative (ICC(C,2) =0.9, F (41,41) = 9.51, p<0.01; CI = 0.8-0.9) and positive emotional content ICC(C,2) =0.94, F (41,41) = 15.9, p<0.01; CI= 0.88-0.97), revealed good reliability. These estimates were based on mean-rating (k=2), consistency agreement, and 2-way mixed effects models.

Descriptive statistics on average coder-ratings, revealed moderate levels of bias-related (M=3.98, SD= 1.44) and negative emotional content (M=3.38, SD=1.63), and minimal levels of positive emotional content (M=0.92, SD = 1.5) (**Table 3E**).

Exploratory analyses on joint dataset

Before combining datasets, it was important to ensure there were no significant differences between the results from the two regions. Drawing on our results from experiments 3A and 3B, we predicted a significant effect of condition (pre and post) but no significant effect of region (North American, International) or interaction effect.

To evaluate our prediction, we entered these factors into a 2-way mixed analysis of variance. Supporting our prediction, the analysis revealed neither a significant difference between the International and Canadian sample $F(1,84) = 1.0$, $p=0.3$, $\eta 2G = 0.009$, nor an interaction effect $F(1,84) = 0.2$, $p=0.7$, $\eta 2G = 0.0004$. The only significant effect was a main effect of condition $F(1,84) = 19.8$, $p<0.001$, $\eta 2G = 0.04$. Echoing the above analyses, participants exhibited greater interval estimates under the post-manipulation ($M= 421.1$, $SD=159.7$) condition, as compared to pre-manipulation ($M= 354.9$, $SD= 153.3$) (**Figure 3F**).

For added confidence, we also explored differences in reported episodic details. To evaluate our prediction of no significant difference between samples, we conducted independent t-tests for each of the six questions (**Table 3F**). All six tests revealed no significant difference in episodic content between samples.

Action-effect interval estimates as a function of bias expectation and expectation confirmation

To examine the effect of expectation confirmation we extracted only the data of those participants who reported their expectation was confirmed ($n= 48$) and those whose expectation was not-confirmed ($n=29$). Data from 77 participants was entered into a mixed two-way analysis of variance (Factor 1: Expectation confirmation - yes and no, Factor 2: Condition - pre and post, DV: Action-effect interval estimates).

The analysis revealed a main effect for condition $F(1,75) = 16.9$, $p<0.001$, $\eta 2G = 0.05$ and expectation confirmation $F(1,75) = 5.2$, $p=0.03$, $\eta 2G = 0.05$, but no interaction effect $F(1,75) = 0.2$, $p=0.7$, $\eta 2G = 0.0005$. Echoing previous results, participants exhibited greater interval estimates under the post-manipulation (M= 431, SD=155) condition compared to pre-manipulation (M= 366, SD= 153). Regarding expectations, participants whose expectation of racial bias was confirmed through their experience reported lower interval estimates (M= 372, SD = 144), as compared to those whose expectation was not confirmed (M= 444, SD = 167) (**Figure 3G**).

Action-effect interval estimates as a function of bias expectation and identity threat

A total of 32 participants reported their identity was threatened, 48 participants report no-threat, and 5 participants provided no responses. After excluding participants who did not respond, action-interval estimates (DV), condition (factor 1), and identity threat data (factor 2) from 80 participants were entered into a mixed two-way analysis of variance.

Like previous analyses, there was a significant effect of condition $F(1,78) = 24.7$, $p<0.001$, $\eta 2G = 0.06$, whereby participants reported lower estimates at baseline (M=356, SD= 153) compared to post-manipulation (M= 426, SD= 160). The effect of condition was qualified by a marginally significant interaction $F(1,78) = 4.1$, $p=0.05$, $\eta 2G = 0.01$ (**Figure 3H**). Follow-up t-tests revealed a significant difference between pre-manipulation and post-manipulation estimates for both individuals whose identity was threatened (pre: $M = 360$, $SD = 135$; post: $M= 466$, $SD = 140$), $t(1,31)= -4.1$, $p<0.001$, $d=0.8$, as well as those whose identity faced no threat (pre: $M = 354$, $SD =165$; post: $M = 399$, $SD = 168$) $t(1,47)= -2.5$, $p = 0.02$, $d = 0.3$. It is important to note that while both levels of the grouping factor revealed significant results, the strength of

the pattern differed. For identity threat, the effect size was considerably larger than the effect size of the no-threat group (*d*=0.8 vs. *d*=0.3). This interaction effect stipulated that while both individuals whose identity was threatened and those whose identity was not threatened demonstrated reduction in agency, the effect was stronger for those whose identity was threatened through the experience.

Action-effect interval estimates as a function of bias expectation and self-monitoring

Participants' responses to the self-mentoring questionnaire were used to generate composite self-monitoring scores for each individual. Drawing on previous research, we classified participants who scored between 13 and 25 on the self-monitoring questionnaire as high self-monitors, and those who scored between 0 and 12 were labelled as low self-monitors (Pornsakulvanich, 2018). Of the 86 participants, 40 were considered high self-monitors and 46 were considered low self-monitors.

Due to violations in homogeneity of variance, the data was entered into a robust two-way mixed ANOVA using trimmed means (20% trimmed means, 2000 bootstraps). The analysis yielded a significant main effect of condition $Q(1,52) = 20$, $p < 0.001$, where participants reported greater estimates post-manipulation (*M*= 421, *SD*= 160), when compared to baseline (*M*=355, *SD*= 153). This main effect was qualified with a significant interaction effect $Q(1,52) = 5.2$, p=0.03. Visual inspection of the interaction plot (**Figure 3I**), revealed that while both low and high self-monitors reported greater post-manipulation scores (low self-monitors: *M* = 434, *SD* = 182; and high self-monitors: *M*= 406, *SD*= 129), as compared to baseline (low self-monitors: *M*= 340, *SD* =169; and high self-monitors: *M*= 371, *SD*= 133), the change in pre-post scores was larger for low-self monitors (-94 milliseconds) as compared to high self-monitors (-

35 milliseconds). The difference between high and low monitors suggests that when low monitors consider a situation where they may be treated with bias, due to their racial identity, they exhibit greater reduction in their sense of agency, as compared to those who are high self-monitors.

3.2.2.3 Discussion

The analyses in this section can be divided into two parts. The first part focused on the effect of racial bias expectation on sense of agency in a new sample of international participants. Here, we replicated earlier results (Experiment 3A), revealing that expectation of racial bias can affect action-effect interval estimates in an international sample. We also found no significant differences in the effect of manipulation nor episodic content of the manipulation, between the samples. The results from this study can be used to substantiate the claim that the effect of racial bias expectation on action-effect interval estimates reflects a true effect in the world. Further, it could be argued that expectations of racial bias may not be as context specific as often depicted. In the face of an interconnected world, racial-ethnic minority groups not only exhibit similar types of bias expectation experiences (episodic detail), but that recollection of these experiences similarly affects sense of agency.

The second part of this section intended to qualify the results observed in both Experiment 3A and 3B. We combined the datasets after confirming no significant differences. We used the joint dataset to assess the role of several psychological experiences we predicted would influence agency by modulating how the expectation of racial bias event was subjectively interpreted. A total of three tests were conducted. We will present our initial interpretation of

the results here, and a more exhaustive explanation in the general discussion section (5. Discussion).

Exploratory analyses

Subjective interpretation of an event, after the fact, plays an important role in how an event is consolidated into memory and how it is recalled. Previous evidence has indicated that expectation confirmation is positively linked with self-esteem and self-efficacy, and since sense of agency is considered a conceptually similar experience, we predicted that such confirmations could also increase agentic experience. Other evidence suggests that expectation confirmation of a negative experience has downstream effects on other correlates of sense of agency, such as mood, and negative mood has been shown to reduce sense of agency. These divergent lines of work made us curious to assess how appraisal of a negative social event could modulate sense of agency. While we did not know the direction of the relation, we did predict a significant interaction effect, meaning that expectation confirmation somehow modulates how the recalled experience affects sense of agency.

Contrary to our prediction, our analysis did not reveal a significant interaction effect. Instead, it revealed two main effects, one of condition and one of expectation confirmation. Regarding expectation confirmation, it demonstrated that people who reported expectation confirmation generally reported greater action-effect interval estimates, which we interpret as greater agency. We speculate that the self-report question about expectation confirmation may have been tapping into a broader construct of confidence or self-assurance, to which it would make sense that people who report higher levels of expectation would exhibit more agentic experience. More research is required for any conclusive interpretation.

The second exploratory test we conducted was on the role of self-identity threat. Previous research has established that the metaphorical bridge between the social world and psychological one, is modulated by our social identity. As an important aspect of our self-understanding, and necessary to the experience of belonging and well-being, threat to one's identity can have dire consequences on self-view, well-being, and performance. For this reason, we predicted that if participants reported social identity threat during the event, they would also exhibit a lower sense of agency post-manipulation. In statistical terms, this would mean that we would find a significant interaction effect between condition and identity threat, such that people who reported identity threat would report greater interval estimates at post-test (lower sense of agency). Our analysis provided support for this prediction. Specifically, people who experienced identity threat reported relatively greater action-effect interval estimates compared to the pre-test than those who did not report identity threat. Echoing previous social psychological research, this finding led us to recognize social identity as an important psychological experience that modulates negative social experiences on psychological phenomena at even the most basic, pre-reflective level. We recommend that future work explore the link between agency and social identity threat further, particularly in other minority populations.

The last exploratory analysis we conducted was to examine the role of self-monitoring. For this analysis, we did not have a specific prediction; rather we wanted to explore *whether* self-monitoring had any effect on agentic experience. Our analysis revealed that both high- and low- self-monitors, report greater action-effect intervals after recalling an experience of bias expectation, but that the change in estimates was steeper for low-self monitors. Said in another

way, we found that when people who do not often modulate themselves to respond in socially appropriate way to social situations (low self-monitors), reflect on how social others would interpret them, in this case racial identity, they reported greater action-effect interval estimates (which we interpret to indicate greater reduction in sense of agency) – as compared to those who consistently regulate themselves (high-self monitors).

Interpretation and next steps

So far, our interpretation of study results has been based on a critical underlying assumption: that racial-ethnic bias expectation is driving action-interval estimate changes from the "pre" intentional binding block to the "post" block. This assumption, while theoretically informed, is premature. There is the possibility that simple recollection of any memory, through the post-manipulation episodic questionnaire, or even a simple effect of time (i.e., larger average interval estimates during the latter intentional binding block). We cannot rule this interpretation out unless we evaluate it using a control condition.

To confidently deduce that changes in our measure of sense of agency are truly due to the content of our manipulation, we decided to administer a control study (Experiment 3C). We planned for the study to mirror the previous studies, in all regards, except for the content of the manipulation. With this design, a non-significant effect of the manipulation on action-effect interval estimates, would afford the ability to argue more definitively that expectations of bias do, in fact, affect agentic experience. A secondary benefit of the control study is that it will allow us to test whether participants revealed distinct episodic content under the bias-expectation condition, compared to the neutral condition. In other words, beyond the descriptive statistics, we will now be able to assess of statistical differences in the content

between conditions. A final benefit of this study is that we will be able to complement previous analyses, with a statistical assessment of episodic content between the three experiments.

3.3 Experiment 3C (North American sample)

3.3.1 Methods

Like experiment 3A, participants were invited to the study via Prolific, if they had indicated they were between the ages of 18 and 65 years, identified as a member of racial-ethnic minority group, and resided in either Canada or America. We selected participants from a North American context, as biases within this context stirred our original research question. Further, because we found no significant differences between intentional binding results in either sample, we believe that data from this sample can serve as a control for both studies.

Of the 118,331 eligible participants, 48 indicated interest, and 44 participants (22 males, 1 left-handed, 18-56 years old, M_{age} = 28.95, SD = 8.27) completed the study for monetary compensation (**Table 3A**).

The Research Design, Procedure, Manipulation check, and Data Processing were identical to the previous studies. The central difference was in the manipulation. Participants were asked to recall the events that took place the day before they took part in the experiment. This type of episodic recall manipulation has been used in previous studies as a control condition (Schwabe et al., 2013). We also made two other small modifications. We did not include expectation confirmation or identity threat self-report questions, as we thought they were irrelevant to the experiences they recalled and might instead confuse participants.

3.3.2 Results

We removed 0.01% of action-effect interval estimates data for meeting outlier exclusion criteria. No participants met the participant exclusion criteria; therefore all 44 participants were included in the final analysis.

Manipulation check

By calculating intraclass correlations and their 95% confidence intervals for coders bias-related, negative, and positive emotional content, we determined good reliability between coders-ratings.

Intraclass correlation coefficients (ICC) and their 95% confidence intervals were calculated. ICC estimates were based on mean-rating (k=2), consistency agreement, and 2-way mixed effects models. Using Koo et al., 2016's guidelines for interpreting intraclass correlations, coders ratings for bias expectation content (bias expectation condition: ICC(C,2) =0.8, F (91,91) = 6.2 $p<0.01$; C1 = 0.76-0.89 and neutral condition: ICC(C,2) = 0.4, F (43,43)= 1.6, p=0.06; CI = -0.1-0.66), positive emotional content (bias expectation emotional content ICC(C,2) = 0.9, F (91,91) = 15.7, $p<0.01$; CI = 0.9-0.96, and neutral condition: ICC(C,2) = 0.8, F (43,43) = 5.5, $p<0.01$; CI = 0.68-0.9) and negative emotional content (bias expectation emotional content ICC(C,2) = 0.9, F (91,91) = 7.5, $p<0.01$; CI = 0.8-0.9, and neutral condition: ICC(C,2) = 0.9, F (43,43) = 10.6, $p<0.01$; CI = 0.8-0.9) demonstrated decent reliability, and provided statistical support to compute average coder-ratings and uses these scores to assess difference in bias expectation and emotional content between conditions.

Shapiro-Wilk tests revealed non-normal distribution of the residuals for positive emotional content (W= 0.94, $p< 0.05$), negative emotional content (W= 0.8, $p<0.01$) and bias

expectation content (W= 0.66, p<0.01), suggesting that a non-parametric test would be most suitable for this data. Wilcoxon ranked sum tests revealed a statistically significant difference in bias expectation V=2907, p<0.01, positive emotional V= 1059, p<0.01, and negative emotional content V=3061, p<0.01 between the bias expectation and the neutral manipulation group. Participants who underwent the bias expectation expressed more bias and negative emotional content but less positive content than those in the neutral condition (**Table 3G**).

Action-effect interval estimates prior to and after neutral experience manipulation

Average intentional binding scores were calculated for each participant under the pre- and post- manipulation conditions and entered into a one-tailed paired t-test. This test revealed no significant difference between intentional binding scores $t(1,42)= -0.83$, $p=0.2$, $d= 0.1$. As we predicted, participants did not report greater interval estimates under the post-manipulation condition ($M= 384.8$, $SD = 169$), as compared to the pre-manipulation condition ($M= 362.8$, $SD = 178$) **(Figure 3J).** The results of this analysis were in line with our prediction that recalling neutral experiences do not reduce action-effect interval estimates.

Episodic content of neutral manipulation

Numerically transformed data from the 6 post-manipulation questions were summarized and inputted into table format (**Table 3H**).

Exploratory assessments

Action-effect interval estimates as a function of neutral experience and self-monitoring

To substantiate the claim that self-monitoring moderates the effect of expectation bias on agentic experience, we wanted to test the effect of self-monitoring on intentional binding after recalling a neutral experience. Using a two-way mixed ANOVA (factor 1: self-monitoring

(high and low), factor 2: condition (pre and post) and dependent variable: action-effect interval estimates), we predicted to find no significant main effects. Our prediction was supported by a non-significant main effect of self-monitoring $F(1,42) = 2.5$, $p=0.1$, $\eta 2 = 0.06$, condition $F(1,42) = 1.77$, $p=0.2$, $\eta 2 = 0.005$, and interaction effect $F(1,42) = 0.94$, $p=0.34$, $\eta 2 = 0.002$ (**Figure 3K**).

Episodic differences between expectations of bias and neutral experiences

It could be argued that the difference between the neutral and expectations of bias on action-effect estimates was due to episodic differences in the memories recalled. After all, recalling an experience from yesterday is different temporally. Thus, it may have affected interval estimate reports.

To test this assumption, we conducted three independent t-tests and 3 Wilcoxon sum rank tests to examine differences between the aggregate bias expectations data (N=86) and the neutral data (N=44). These analyses revealed three significant differences (**Table 3I**). Participants who recalled bias expectation events reported the event to be more personally relevant at the time it occurred (M=4.59, SD= 1.46), compared to those who recalled the neutral event (M=4.07, SD =1.32). This same group also reported thinking or speaking about the event less often (M= 2.23, SD = 1.46 vs. M=3.16, SD = 2.03). Lastly, they rated the experience more negatively.

3.3.3 Discussion

The goal of this section was to help rule out the possibility that changes in action-effect intervals were due to mere time effects or simply a result of engaging in an episodic manipulation task. We found a non-significant difference in action-effect interval estimates when participants completed a neutral episodic recall manipulation about what they did the

previous day. Exploratory analyses on the effect of self-monitoring on neutral experience and intentional binding, further supported this claim. As per our predictions, in the neutral condition, we found no significant effect of self-monitoring on the neutral manipulation and intentional binding. That said, an exploratory analysis of episodic content between the studies on expectation bias and the study on neutral experience, revealed some significant differences in the personal significance of the event at the present time, the valence of the experience recalled, and how often people thought about the event. Regarding personal significance, participants who reported expectation of bias deemed the event more personally important than the neutral event. In terms of the difference between thinking about the recalled experience, people in the neutral condition reported a much more frequent recollection. Finally, participants who recalled an expectation of bias experience reported more negative emotions.

In reflecting on these differences, it makes sense that an experience related to social identity would be judged as more personally important and more negatively valanced. Also, given the lack of time constraint for the expectation of bias manipulation, it also makes sense that these people would report experiences further in time than the neutral condition, who were asked to report on an experience from the near past (yesterday). However, it may be argued that these differences may have contributed to the difference between expectations of bias and the neutral condition. We speculate that the difference in valence and temporal difference in which the memory was formed may have contributed to the difference in action-effect intervals reported. The reason for this is that there is previous evidence to indicate that adverse social experiences are also coupled with negative emotions, as compared to more

favourable social experiences (Obhi et al., 2013; Malik & Obhi, 2019). Additionally, previous research has established that time (Ruess et al., 2017; 2018) and distance (even physical) can modulate the binding effect (Jenkins & Obhi, 2021). Thus, while there is evidence that expectations of bias modulate sense of agency, and that neutral memories of our previous day's experience may not, we must consider the role of some core episodic differences when interpreting the results and relating them to our general question about agency.

3.4 General Discussion

This chapter brought together social cognitive research on SIT and neurocognitive research on intentional binding to explore the role of racial bias expectations on the pre-reflective sense of agency amongst racial minorities. Recognizing the role of sense of agency for human self-consciousness, volition, and well-being (Moore, 2016; Haggard, 2017) and the negative downstream effects of SIT on self-related processes and performance (Major & O'Brien, 2005), we predicted that expectations of racial bias would reduce the sense of agency, as indexed by lower action-effect interval estimates post-manipulation. Additionally, we predicted that our exploratory measures, including the confirmation of expectations through one's experiences and perception of identity threat, would further reduce intentional binding (i.e., greater action-effect interval estimates post-manipulation). For our final two exploratory measures, which included an episodic detail questionnaire and self-monitoring scale, we did not have any explicit predictions for these measures. We simply wanted to examine if these measures influenced our results in any way.

We tested our predictions across three separate studies. The first two assessed our predictions within a North American and international context. The third study was a control

study, which explored the role of neutral expectations on the sense of agency. Across all three studies, we relied on an episodic recall task to manipulate perceptions of bias expectations (and neutral experiences) and the intentional binding task to index sense of agency.

Study 3A and 3B

For the two studies on racial bias expectations, we found evidence supporting our prediction. In both samples, racial minorities reported greater action-effect interval estimates post-manipulation (i.e., reduced intentional binding) after engaging in the episodic recall task about racial bias expectations. In terms of our exploratory analyses, we found that both individuals whose identity was threatened and those whose identity was not threatened reported greater interval estimates (lower sense of agency). However, the effect was stronger for those whose identity was threatened through the experience. This finding is important as it adds to current social cognitive work on racial-ethnic minorities. As alluded to in the introduction section, researchers have suggested that a key mechanism through which expectations can affect outcomes is by threatening social identity (Branscombe et al., 1999; Major & O'Brien, 2005; Major & Schmader, 2018). The reason for these broad consequences is that social identity is intimately linked with self-experiences, and threat to this identity, by the fact that someone could view/treat them differently due to a stigmatizing feature, is enough to trigger negative outcomes (Steele et al., 2002; Major & O'Brien, 2005). In short, this finding suggests that, at least for the experience of sense of agency, that social identity threat is not deterministic of impairment. While it can and does reduce sense of agency more drastically; people do not need to experience threat to experience a reduction in the sense of agency. We believe this finding is worthy of being further explored by research researchers. Researchers

may want to consider social identity threat, for other stigmatized groups to gain a better understanding of the generalizability of the effect.

Our exploratory analysis on self-monitoring, suggested that low-self-monitors, as compared to high-self-monitors, reported greater interval estimates post-bias expectation manipulation. This suggests that when people who have trouble adapting to new contexts (Iches et al., 2006) reflect on a time they expected to treat or viewed with bias, they tend to experience lower sense of agency than someone who has less trouble adapting to new contexts. It is important to clarify that this is a relative difference. Both low and high-self-monitors experience a reduction in their sense of agency when reflecting on a time when they expected to be met with bias. However, the severity of the effect is much stronger for low-self-monitors.

Lastly, our exploratory analysis on bias expectation confirmation revealed less clear results. We found that when people expectations of bias were confirmed through their experience, they reported greater interval estimates (lower sense of agency). Because we were interested in an interaction effect, and this ad hoc interpretation of the experience is difficult to understand with the current data, we do not attempt to make any conclusive interpretations here. Rather, we suggest that future research look into this topic, and particularly, validated measures that may be linked to it, for a comprehensive understanding.

Study 3C

We recognized that as compelling as the findings in the two studies were, we could not conclude that the changes in temporal perception were based on the content of the episodic memory task (i.e., racial bias expectation). To be able to conclusively interpret these results, we

decided to conduct a final study on the effect of a neutral episodic recall prime. We predicted that this type of prime would not reduce sense of agency (as indexed by equal or lower interval estimates) post-manipulation. As per our prediction, we found no significant difference in interval estimates from before to after the manipulation. Additionally, we assessed self-monitoring scores. This analysis also revealed no significant effect of self-monitoring on interval estimates.

Advancing social cognitive and neurocognitive work

Starting with the neurocognitive literature, to our knowledge, this research program is the first line of work in the field, which has attempted to understand how the sense of agency is modulated within the minds of racial minority groups. While this field is invested in better understanding social contextual and psycho-social factors that modulate the experiences, we have yet to know of any work that has focused on distinct social groups, particularly stigmatized ones. For the social cognitive literature, the insights from this research program suggest that expectations of bias, and social identity threat (SIT), more broadly, may affect stigmatized groups' experiences by shaping their pre-reflective processes, such as their sense of agency. This insight is important as it advances the current literature on the impact of SIT on self-related processes, which has, to date, focused on measuring reflective self-related processes, such as self-efficacy and personal control, using self-report scales.

By bringing together these two fields and research topics, this research program provides future researchers with considerable insight and direction for new research. Social cognitive researchers may want to aim at replicated these findings across other social groups, especially other stigmatized groups, to understand if these findings are exclusive to racial

minorities or if they extend to people with other socially stigmatized identities, such as persons with a physical disability, or people with criminal charges. It may be particularly interesting for these researchers to explore how expectations of bias affect the sense of agency amongst people with concealable stigmas (such as mental illness) as compared to those with more apparent stigmas (such as physical disabilities and race), as ongoing research suggests these groups may experience and navigate the social world differently (Moore et al., 2016; Quinn et al., 2020). Neurocognitive researchers may want to investigate what these findings mean in the context of different theoretical models that explain the emergence of sense of agency, such as the Comparator model and Multifactorial models (Moore et al., 2016). While there have been considerable advancements in the modulators of intentional binding, ongoing work is still focused on understanding the role of predictive and posdictive cues on the sense of agency (Malik et al., 2022). Lastly, drawing on other implicit tools in the literature, such as sensory attenuation, i.e., the perceptive compression of sensory input for self-generated actions, researchers may want to employ these other tools to gain a deeper understanding of how racial bias expectations affect sense of agency (Pyasik et al., 2021).

Limitations

This research program was limited in the way it was administered. Over the last twenty years, the task has traditionally been administered in controlled lab settings (Haggard et al., 2002; Barlas et al., 2019). Through the rigid confines of such a space, direct conclusions can be made about changes in interval estimates before and after experimental manipulations. Violating this tradition, COVID restrictions led us to administer our studies online. Although we explicitly asked participants to complete the task in a quiet space without other people and use

earphones to mitigate distractions, it does not eliminate the fact that the study was being conducted in an uncontrolled setting. Further, it does not entirely rule out the influence of external factors that may confound results. That said, we do believe our results can be interpreted with some level of confidence, given recent research assessing the feasibility of measuring intentional binding online (Galang et al., 2021). This pre-registered online study suggested that intentional binding effect could be observed in an uncontrolled online setting (Galang et al., 2021), leading many other researchers to also move their research online (Torrentira, 2020; Soral et al., 2021; Scott et al., 2022). Important to note, however, is that, unlike our studies, the cited studies relied on the more extensive Libet clock method rather than interval estimate version of intentional binding, which we used.

Another limitation is that for experiment 3C, ICC tests revealed that coders' ratings for the neutral manipulation were not highly consistent. This contrasts coders' scores for the bias expectation manipulations. Because the goal of experiment 3C was to ensure confidence in our claim that biased expectations, but not neutral experiences, reduce intentional binding, the discrepancy in manipulated content serves as a limitation to account for when interpreting the results of this research program.

Chapter 4: Psycho-social modulators of the sense of agency

"The whole sting and excitement of our voluntary life . . . depends on our sense that in it things are really being decided from one moment to another, and that it is not the dull rattling off of a chain that was forged innumerable ages ago" -William James (1890)

The goal of this thesis was to better understand psycho-social modulators of the sense of agency. We decided to focus on the sense of agency, given its role in underlying basic human experiences, such as self-consciousness (Newen & Vogeley, 2003; David et al., 2008; Haggard & Chambon, 2012; Braun et al., 2018; Stern et al., 2020), free will and responsibility (Leptourgos & Philip, 2020; Haggard, 2017), as well as its influence on voluntary actions (Jeannerod et al., 2004; David et al., 2008; Hoerl et al., 2020; Silver et al., 2020). We were afforded the capacity to investigate this topic based on a recent advancement in the neurocognitive literature, i.e., the intentional binding effect, which has allowed researchers to assess changes in sense of agency experimentally by examining changes in temporal perception across experimental conditions that are theoretically linked with more or less agentic experience (Moore & Obhi, 2012).

To advance research on psycho-social modulators of the sense of agency, we decided to observe the impact of these modulators amongst people who may be more prone to experiencing specific/emotionally laden experiences. Through a survey of the social cognitive literature, we decided to focus on stigmatized groups, and more specifically, racial-ethnic minorities. For our first two experiments, we assessed the role of perceived racial stigma, i.e., being discounted by one's membership in a racial minority group (Goffman, 1963; Major & O'Brien, 2005), on intentional binding, and for our second study, we examined the role of

perceived racial bias, i.e., being evaluated based on generalizations about one's racial group (chapter 2) (Edmond et al., 2001). We relied on a two-way repeated measures design, where participants underwent a block of intentional binding, before and after, being manipulated to a negative psycho-social experience (i.e., racial bias or stigma) or a positive psycho-social experience (racial acceptance). We predicted, based on recent neurocognitive work on intentional binding, that racial stigma and bias, as compared to racial acceptance, would reduce intentional binding, as indexed by greater action-effect estimates after the racial stigma and bias manipulations. Additionally, we investigated the role of internalized stigma and personality as exploratory variables that may affect baseline sense of agency. We predicted that people with high-levels of internalized stigma would exhibit greater action-effect interval estimates at baseline, but we did not have any predictions for personality. Across both studies, we found that participants reported greater action-effect interval estimates post-manipulation. In other words, participants reported greater interval estimates after both positive and negative psycho-social experiences. For the exploratory measures, we did not find any significant associations.

Given the surprising nature of our findings, we reasoned that the type of research we were engaged in could not be done without consulting the social cognitive literature. Namely, for these initial studies, our predictions were informed by neurocognitive research on intentional binding. We consulted the social cognitive literature only to draw upon a population and set of experiences of interest. However, we failed to assess how researchers understood the impact of these experiences amongst racial-ethnic minorities. To bridge this gap, we decided, for our next few studies, to review the social cognitive literature on stigmatized groups, and use theoretical and empirical insights from this work to inform our predictions

(chapter 3). This review of the literature brought us to acknowledge the role of expectations in the lives of racial minorities. For stigmatized groups, researchers have suggested that a core psychological mechanism that affects people's actions and well-being is a situationally triggered expectation of devaluation based on one's group membership and that this expectation affects a range of internal and behavioural outcomes by threatening people's motivation to maintain a positive self-view (Major et al., 2018). Recognizing the role of self-related processes and the negative impact of expectations of bias on experiences that the sense of agency underlies, i.e., wellbeing and performance, we predicted that these expectations would reduce the sense of agency amongst racial-ethnic minorities.

To adequately assess the mechanisms that affect the sense of agency in this group, we considered the role of expectations of devaluation, as well as two important exploratory variables: perceived identity threat, and confirmation of expectations – which we predicted would be linked with even worse sense of agency. The decision to include these two measures was based on theoretical and empirical evidence that these experiences play in the lives of stigmatized groups. Lastly, we explored the role of self-monitoring, i.e., the extent to which people self-regulate based on social cues. We did not have any predictions for this measure.

Across three experimental studies, we found that expectations of bias, but not neutral experiences, reduced the sense of agency, as indexed by greater action-effect interval estimates, as compared to baseline. We found that people who perceived identity threat, and people who were low self-monitors reported greater action-effect intervals, post-manipulation. Further, people who reported their expectation of bias was confirmed generally reported greater action-effect interval estimates. Together, these lines of research demonstrated that for

racial-ethnic minorities, expectations of racial bias critically affected people's sense of agency, and the extent to which it did this was influenced by people's perceptions (i.e., identity threat) and individual factors (i.e., the extent to which people were high-low self-monitors).

The five studies summarized in this thesis provide us with some initial evidence on the role of psycho-social experiences on the sense of agency amongst stigmatized groups. However, as an early line of research, our interpretations must be taken with some caution. One reason for this is based on the order effects observed in the first two studies. Across these studies, we found that participants who were assigned to one counterbalanced condition (for example, acceptance first) reported greater action-effect interval estimates, as compared to those assigned to the other counterbalanced group. To try and obtain some clarity, we decided to investigate just the first session, i.e., pre-post manipulation one. Our analysis for experiment one, replicated the previous findings, suggesting that the condition people were assigned to first affected general intentional binding estimates. Yet, for our second experiment, analysis of data from session 1, revealed that participants reported greater post-manipulation estimates, and that there were no significant differences in estimates between the counterbalanced groups. Because our initial study focused on a convenience sample and was low-powered, while our second study was based on a representative sample and high-powered, we decided to maintain our interpretation of the study findings as suggestive of the fact that both positive and negative psycho-social experiences can modulate the sense of agency – however, we deem it essential for these studies to be replicated to increase confidence in our results.

Neurocognitive perspective implications and consideration

In this thesis, we assumed that the sense of agency is a necessary and important self-related experience that assists racial-ethnic minorities in navigating their environment. While this assumption was based on decades of research suggesting the sense of agency is a basic/fundamental human experience necessary for volition and well-being (Gallagher, 2012; Moore, 2016; Haggard, 2017), one may question this assertion based on research from the social cognitive literature. Ongoing work in the social cognitive literature has focused on teasing apart the role of different self-related processes, which have been traditionally seen as protective factors, and assessing their impact on diverse groups (Hughes & Demo, 1989). With careful attention to the group of interest, researchers have revealed some intriguing results. For example, researchers have found that while greater sense of mastery is linked with less distress for African American women, it does not have this protective role for African American men (Assari, 2019). Additionally, two meta-analyses (Gray-Little & Hafdahl, 2000; Twenge & Crocker, 2002) revealed that African Americans reported greater self-esteem than Whites. At the same time, researchers have revealed that an internal locus of control is critical for decision-making, and performance related to careers for both Black and White youth (Lease, 2004). The nuanced findings lead us to question the assumption that self-related processing universally supports diverse groups. We believe this assumption should be tested, to understand the implications of the self-related processing, and specifically, pre-reflective sense of agency for diverse social groups.

It is important to note that this entire thesis rests on the assumption that the intentional binding effect is an implicit measure of the pre-reflective sense of agency. While there is considerable evidence to suggest this (Malik et al., 2022), the truth of the matter is this

assumption is still being evaluated. Additionally, it is important to note that there are several researchers who have argued against the assumption that intentional binding measures the sense of agency, and that it is instead a measure of causality or multisensory integration (Obhi & Moore, 2012; Buehner, 2012; Kirsch et al., 2018). Further, others have suggested that the intentional binding task is a forced choice task rather than a free choice, as participants have only one option (i.e., pressing the space bar). However, this critique has been challenged by researchers who've said that regardless of whether it is a *free choice* or *forced choice* task, the task prompts participants to be aware of their agency when selecting to act, and that is what is important for the purposes of an implicit measure of sense of agency (Frith, 2013; Gozli, 2019).

Social cognitive perspective implications and consideration

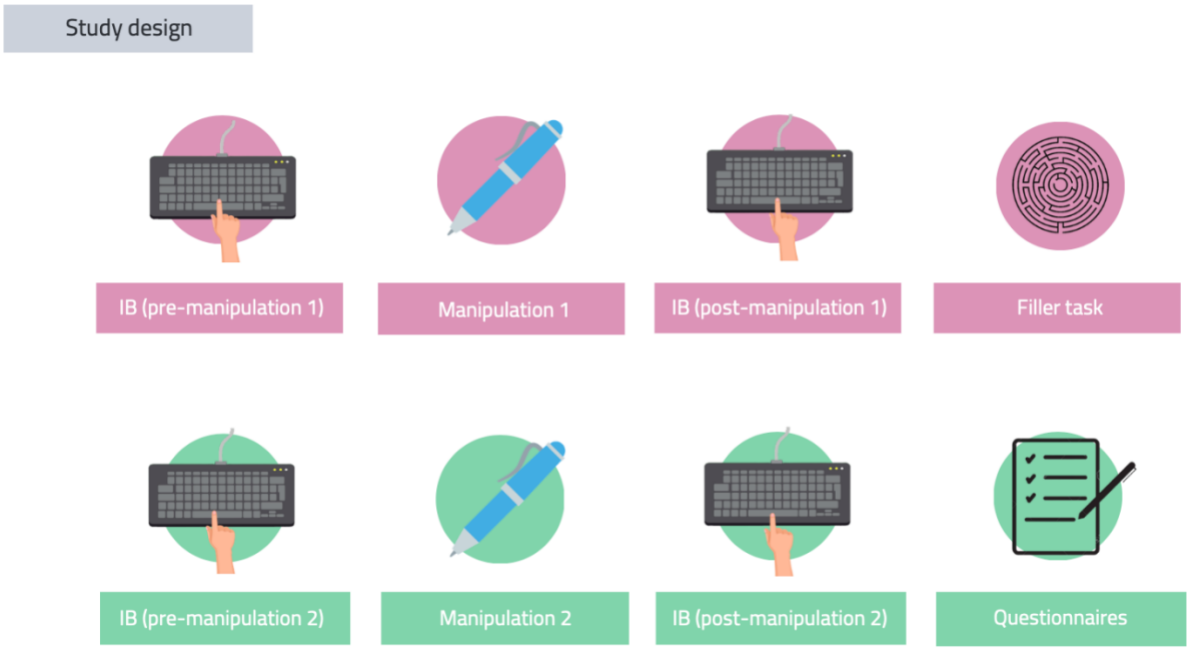
We believe that a core strength of our work is that we examined the lived experience of racial-ethnic minorities, as an important source of data. This type of research is vital, given previous limitations in the field. Namely, researchers have suggested that prior social cognitive and social scientific work on racial-ethnic minorities has focused on the impact of external constraints, and the perceptions and behaviours of social others on racial-ethnic minorities. The consequence of this trend, is that it has led racial minorities to be viewed as agents and subjects of research, and racial minorities as passive targets of evaluation and objects of evaluation (Oyserman & Swim, 2001; Howarth, 2006). Within our studies, the conscious decision to focus on racial-ethnic minorities' experiences provides important insights into the active role these individuals play in processing and understanding their conditions, and how the process of grappling with this information affects their outcomes.

In saying this, we want to be very clear in that we are not absolving responsibility from social-institutional processes, nor non-stigmatized persons, as these factors critically shape the conditions that racial-ethnic minorities navigate (Smedley, 2012; O'Neil, 2018; Elias et al., 2021). Further, we recognize and advise that our work, and future work on the topic, be used to impact policy and practices in tandem with social scientific research as well as social psychological research, on external challenges/concerns. It is only by understanding the multitude of factors at play that true change can take place.

Appendix

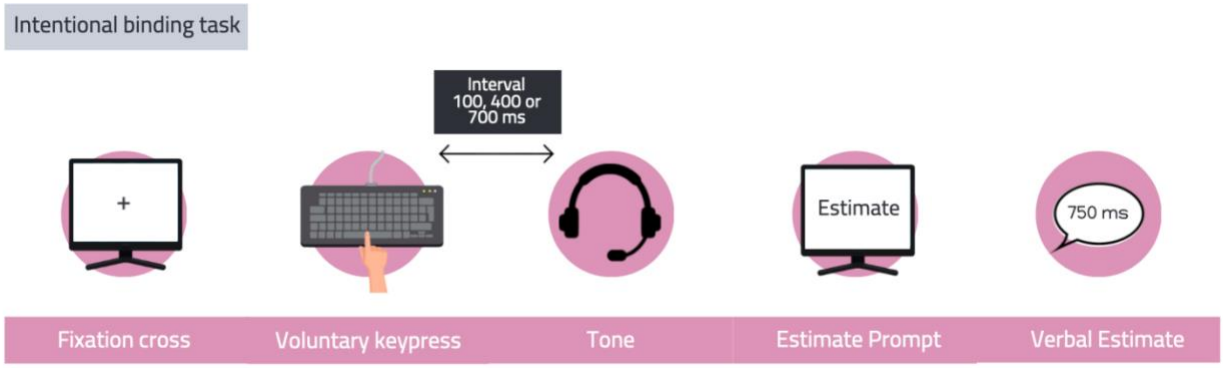
Figures

Figure 1A. Stigma-acceptance study research design



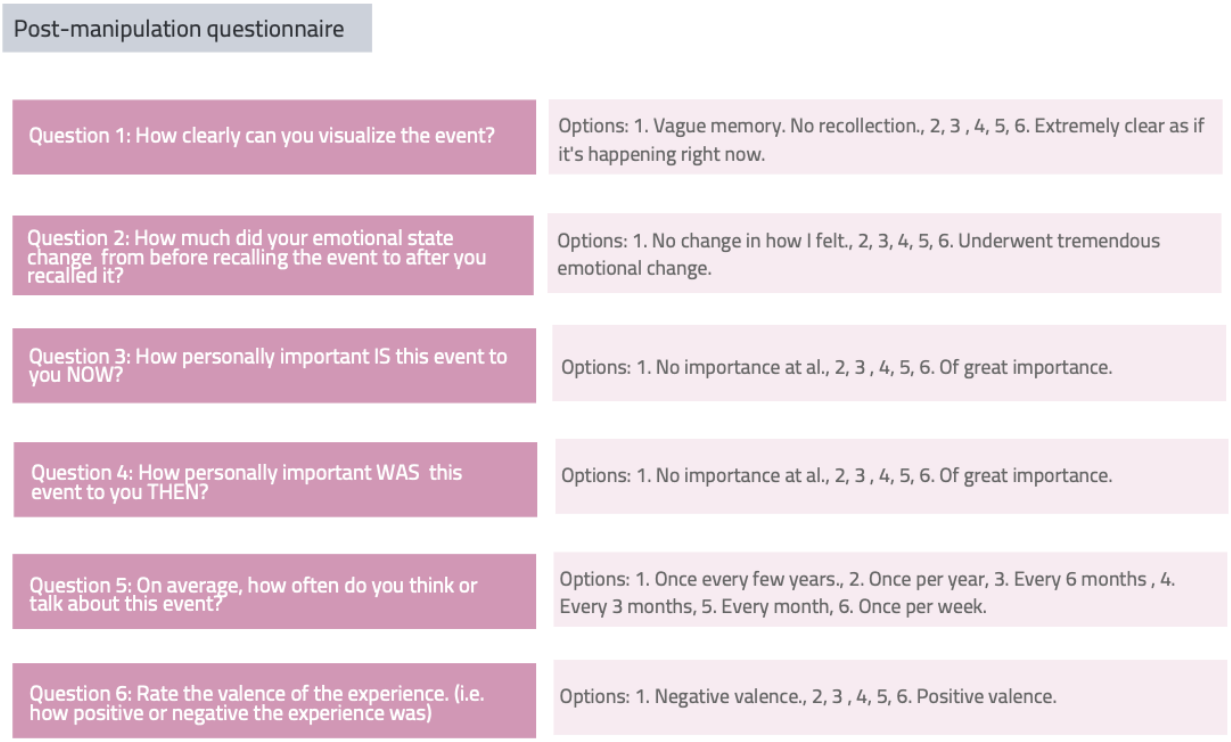
This figure outlines the research design. Participants began with the first intentional binding (IB) block, the first manipulation, followed by a post-manipulation IB block. Next, participants engaged in a filler maze task and then repeated the same three tasks; the only difference is that a second manipulation was presented. The experimental session ended with a demographic questionnaire, a short self-stigma questionnaire and the big-5 personality test. Note: In this image, manipulation 1 and 2 are used in place of the terms acceptance and stigma manipulation to highlight that the order of manipulations was counterbalanced across participants.

Figure 1B. Guided intentional binding task



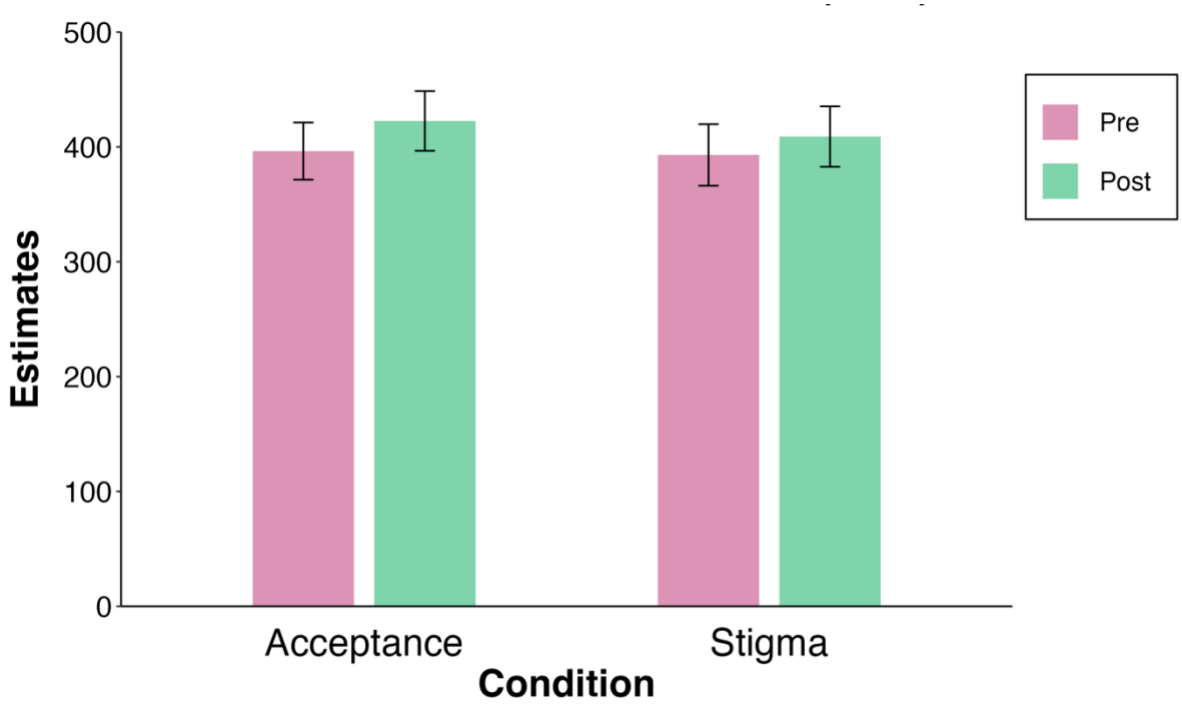
This figure represents all the major events in one trial of the intentional binding task. Each trial began with the presentation of a fixation cross on the screen. At the time of their choice, participants pressed the spacebar on the keyboard. The keypress triggered an auditory tone after an interval of 100, 400 or 700 milliseconds. After the tone, the computer prompted participants with the word "Estimate." In response to this message, participants verbally reported the perceived time between the keypress and the tone. Interval estimates were restricted to lie between a set range: 0 to 999 milliseconds.

Figure 1C. Episodic detail questionnaire



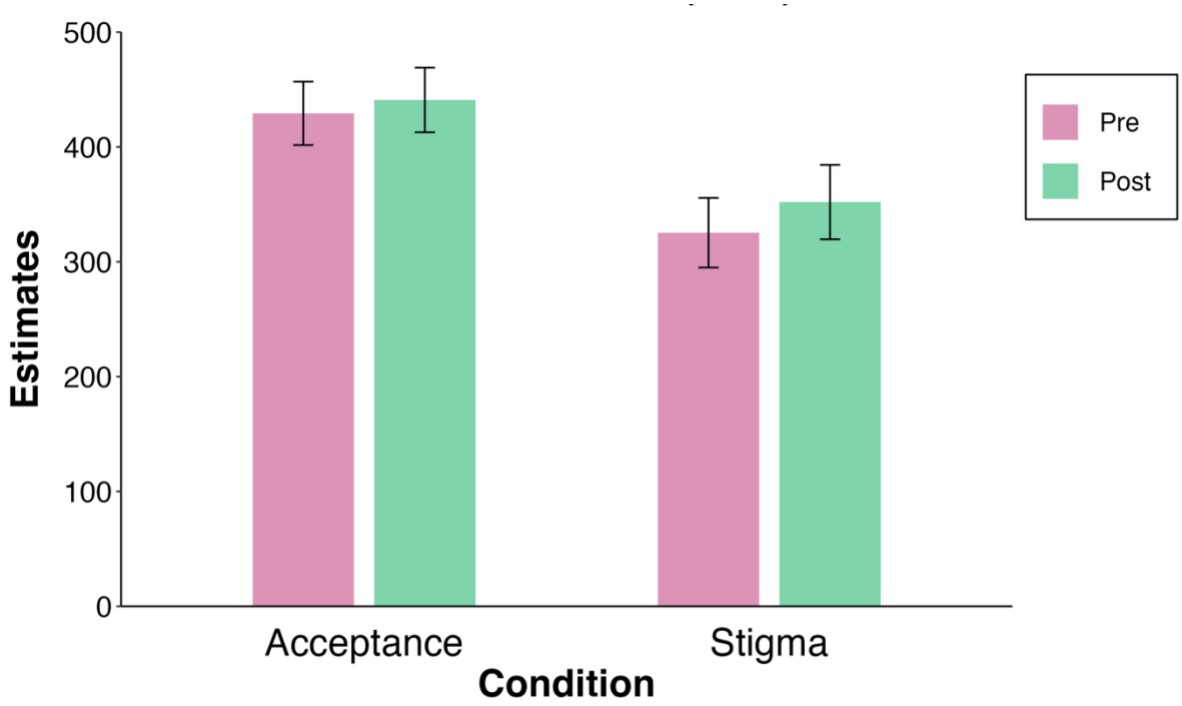
This survey is based on one developed by Addis et al., 2008, and builds on the work of Levine et al., 2002.

Figure 1D: Bar plot examining the effect of racial stigma and acceptance on action-interval estimates



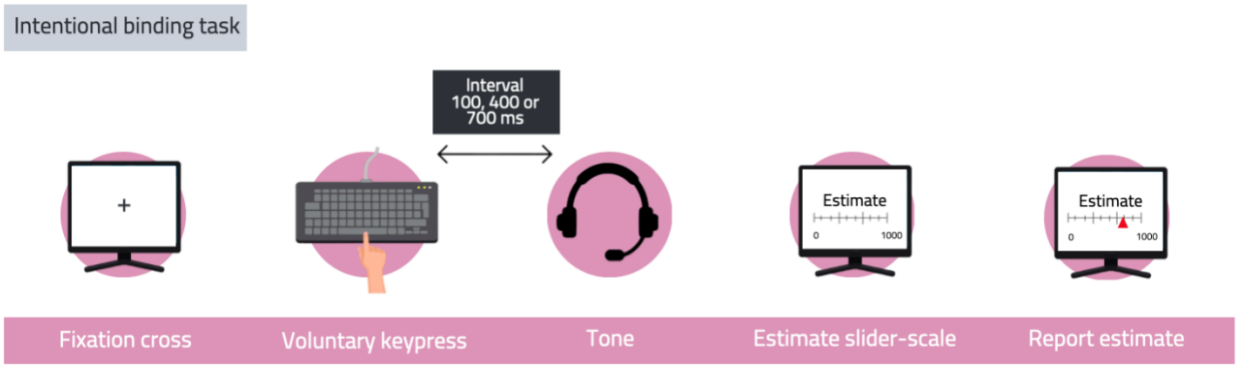
This bar plot displays mean participants' interval estimates (and standard errors) pre-post racial acceptance and stigma manipulation. As per the 2-way repeated measures ANOVA, we observed an effect of time, such that participants reported worse sense of agency (lower temporal binding) after each manipulation, regardless of the condition.

Figure 1E: Bar plot examining the effect of racial stigma and acceptance on action-interval estimates for Session 1



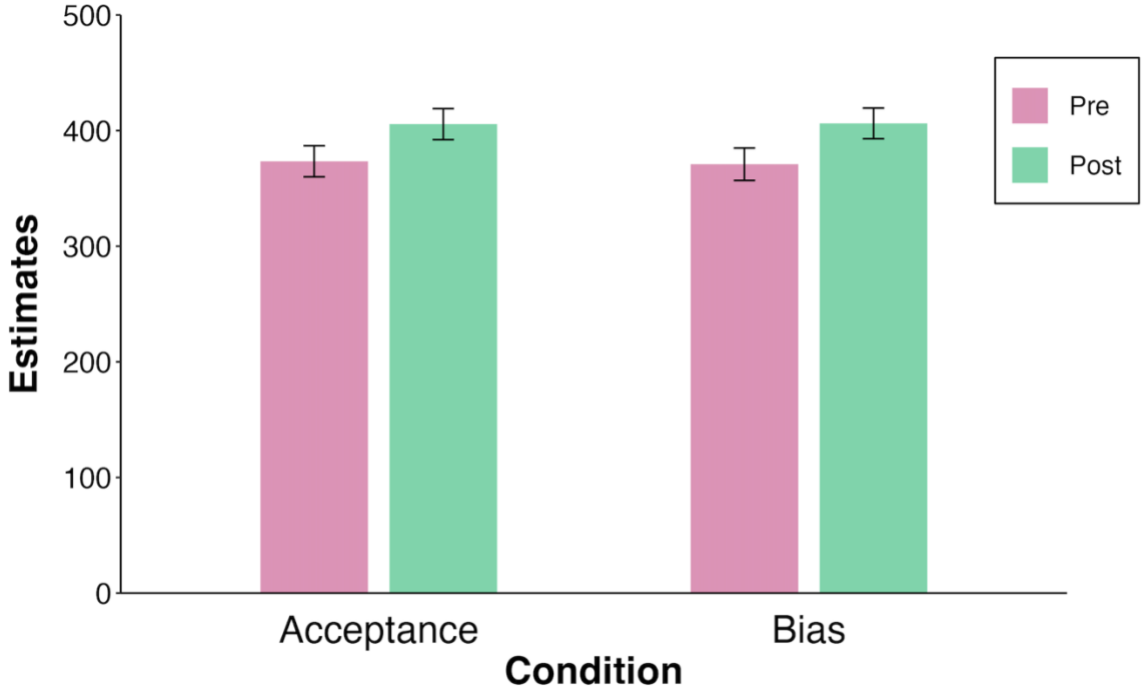
This bar plot displays participants' mean interval estimates (and standard errors) for the first session of the study. Those in the acceptance condition are those that underwent acceptance in the first condition, and those in the stigma condition are those that underwent the stigma condition first. As per the 2-way Mixed ANOVA, we observed an effect of condition, such that participants reported worse sense of agency when they underwent acceptance in the first session, as compared to those who underwent stigma in the first session.

Figure 2A. Autonomous intentional binding task



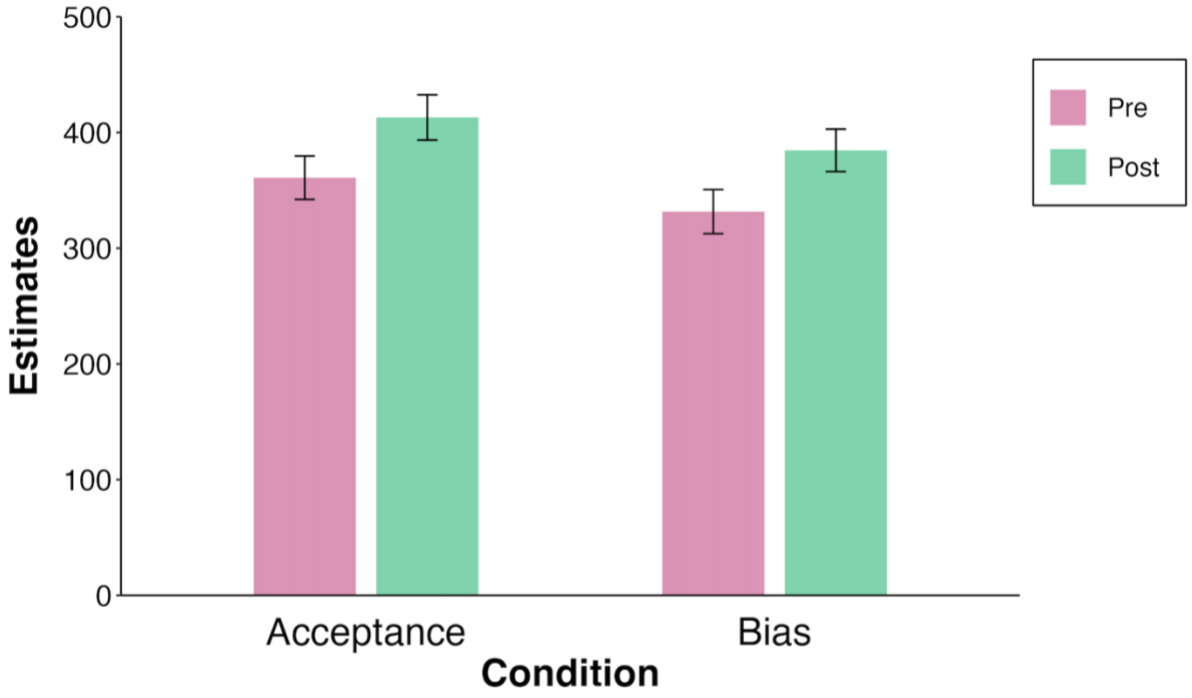
This figure represents all the major events in one trial of the intentional binding task. Each trial began with a fixation cross on the screen. Participants pressed the spacebar on the keyboard at a time of their choice. The keyboard triggered an auditory tone (1000 Hz, 100 ms) after an interval of 100, 400 or 700 milliseconds. After the tone, the computer prompted participants with the word "Estimate" and presented a slider scale. Participants reported their estimates on the slider scale by clicking the appropriate section on the scale or dragging the slider to the appropriate numeric estimate.

Figure 2B: Bar plot examining the effect of racial bias and acceptance on action-interval estimates



This bar plot displays participants' interval estimates pre-post acceptance and stigma manipulation. As per the 2-way ANOVA and image-text, we observed an effect of time, such that participants reported worse sense of agency after each manipulation, regardless of the condition. The error bars represent standard error.

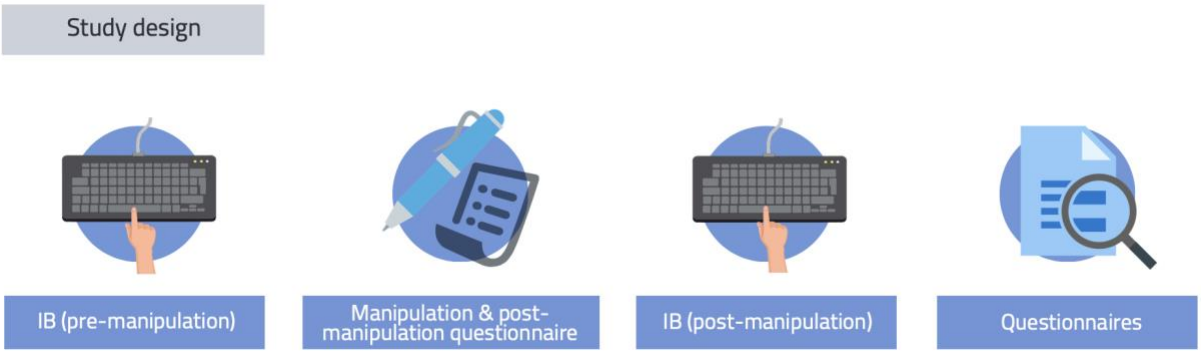
Figure 2C: Bar plot examining the effect of racial stigma and acceptance on action-interval estimates for Session 1



This bar plot displays participants' interval estimates for the first session of the study. Those in the acceptance condition are those that underwent acceptance in the first condition, and those in the stigma condition are those that underwent the stigma condition first. As per the 2-way Mixed ANOVA, we observed an effect of time, such that participants reported worse sense of agency (i.e., greater action-effect intervals) post-manipulation.

Figure 3A

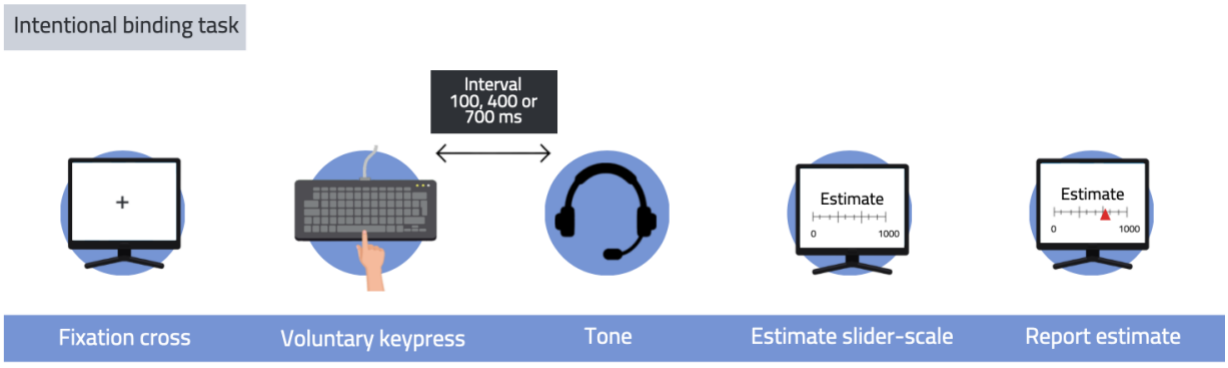
Research design



This figure outlines the research design. Participants began with the baseline intentional binding block, followed by the bias expectation manipulation and the post-expectation IB block. The experimental session ended with three questionnaires: demographic, self-monitoring, and social phobia questionnaire.

Figure 3B

Schematic of the intentional binding task

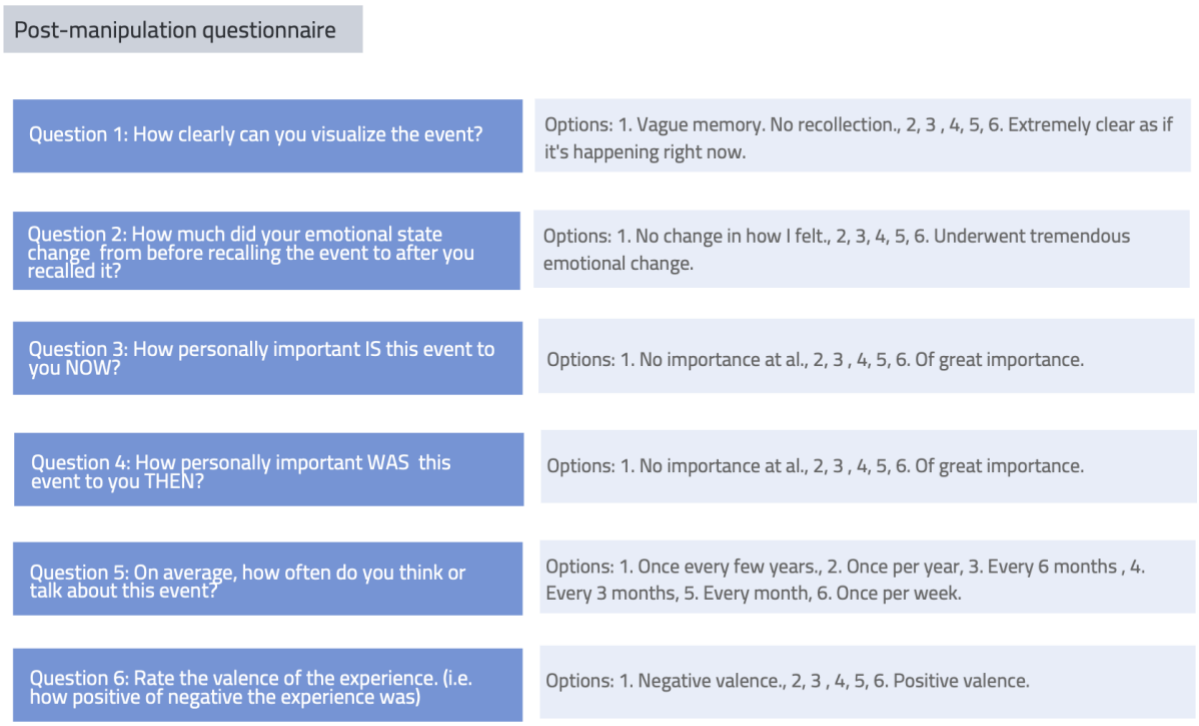


This figure represents all of the major events in one trial of the intentional binding task. Each trial began with a fixation cross on the screen. At the time of their choice, participants were asked to press the spacebar. This action triggered an auditory tone (1000 Hz, 100 milliseconds)

after an interval of 100, 400 or 700 milliseconds, followed by a screen with the word "Estimate" and a slider scale. To report action-outcome estimates, participants clicked the appropriate section on the scale or dragged the slider to the appropriate numeric estimate. After inputting their response, they could press next, to proceed to the next trial.

Figure 3C

Post-manipulation episodic detail questionnaire



This survey is based on the work of Addis et al., 2008, and builds on the work of Levine et al., 2002.

Figure 3D

Barplot depicting average action-effect interval estimates pre- and post-manipulation

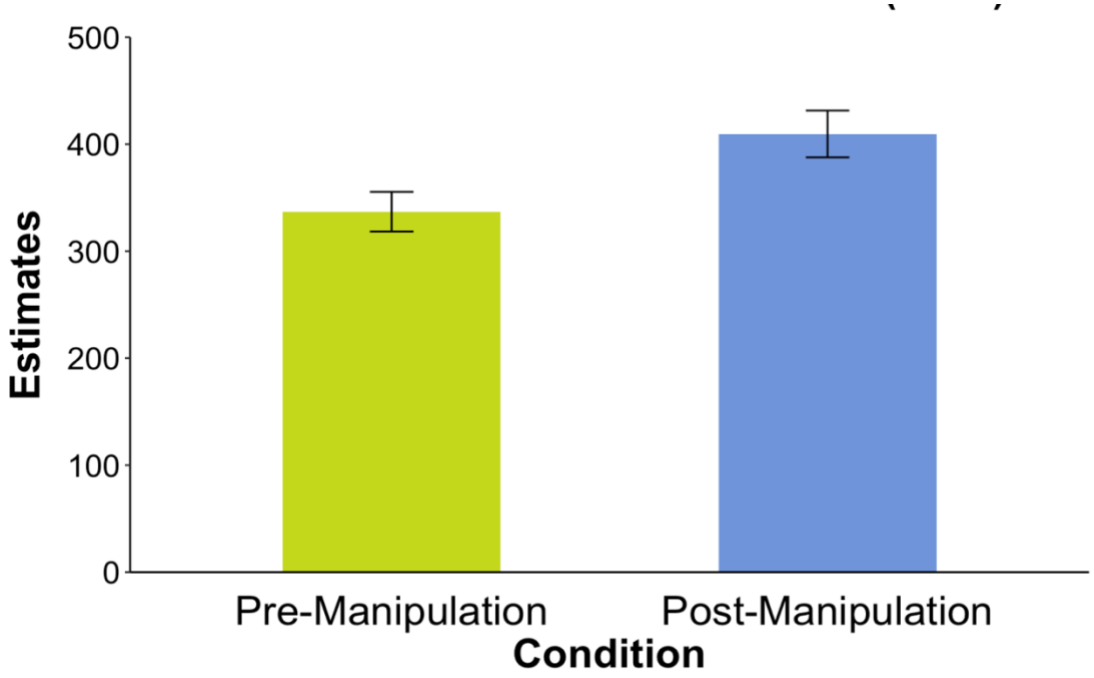


Figure 3E

Barplot depicting average action-effect interval estimates before and after expectation bias manipulation. The error bars represent standard error.

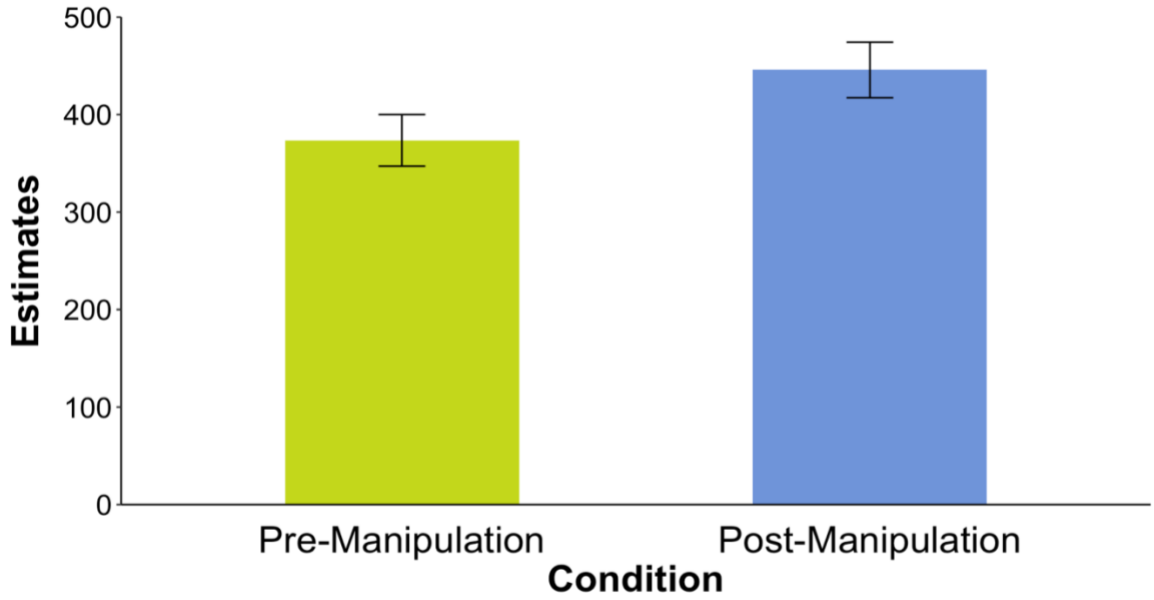


Figure 3F

Barplot depicting the role of region and condition on action-effect interval estimates. The error bars represent standard error.

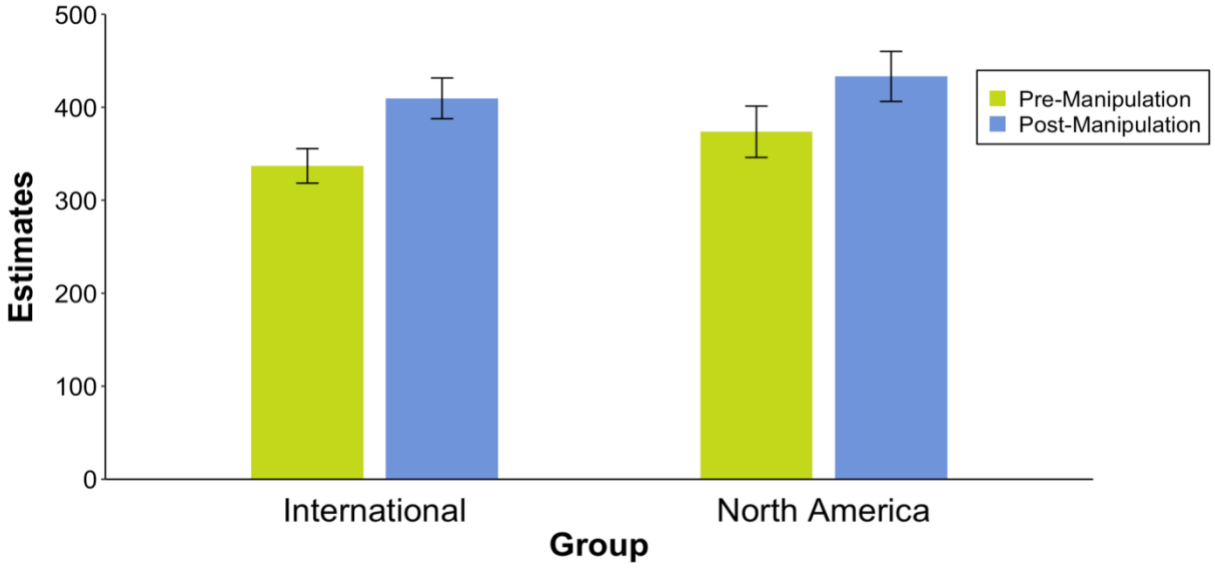


Figure 3G

Barplot depicting the role of expectation confirmation and condition on interval estimates. The error bars represent standard error.

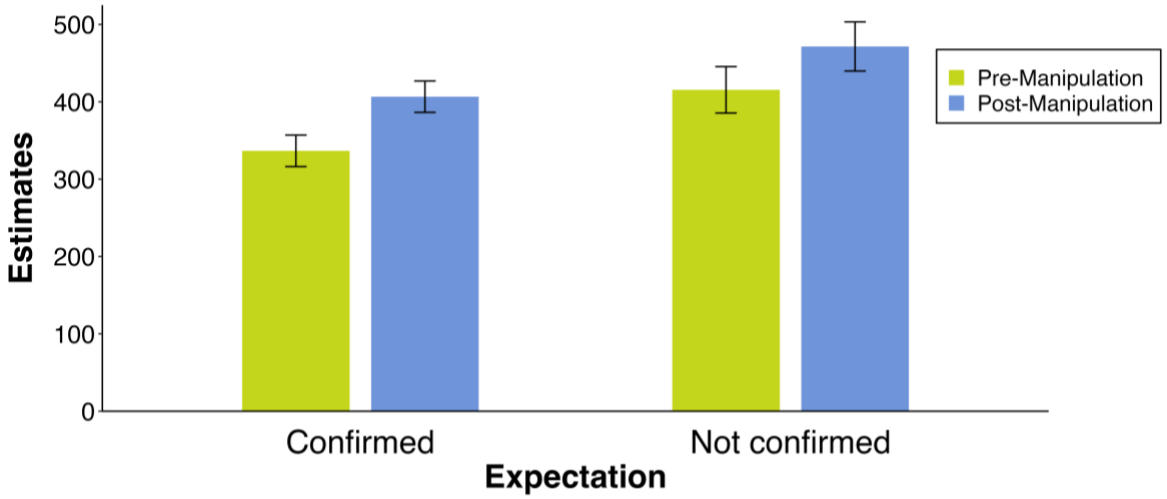


Figure 3H

Lineplot depicting the role of identity threat and condition on action-effect interval estimates. The error bars represent standard error.

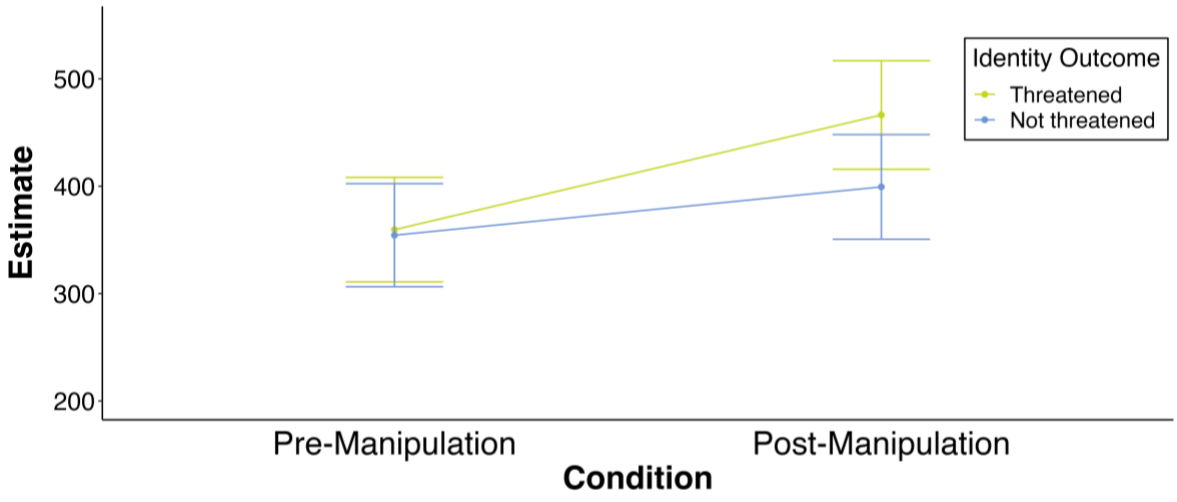


Figure 3I

Lineplot depicting the role of self-mentoring and condition on interval estimates. The error bars represent standard error.

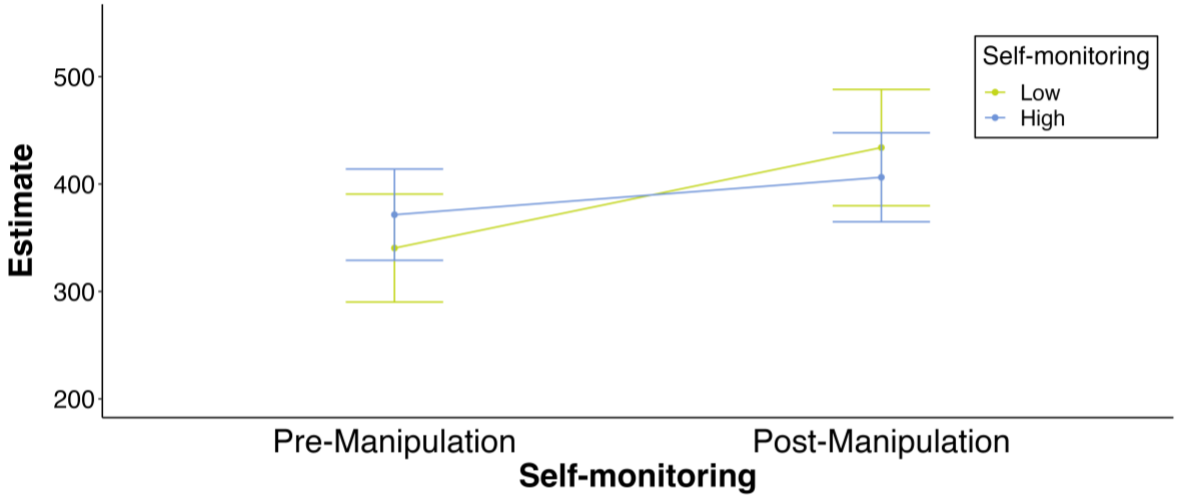


Figure 3J

Barplot depicting the effect of neutral manipulation condition on action-effect interval estimates. The error bars represent standard error

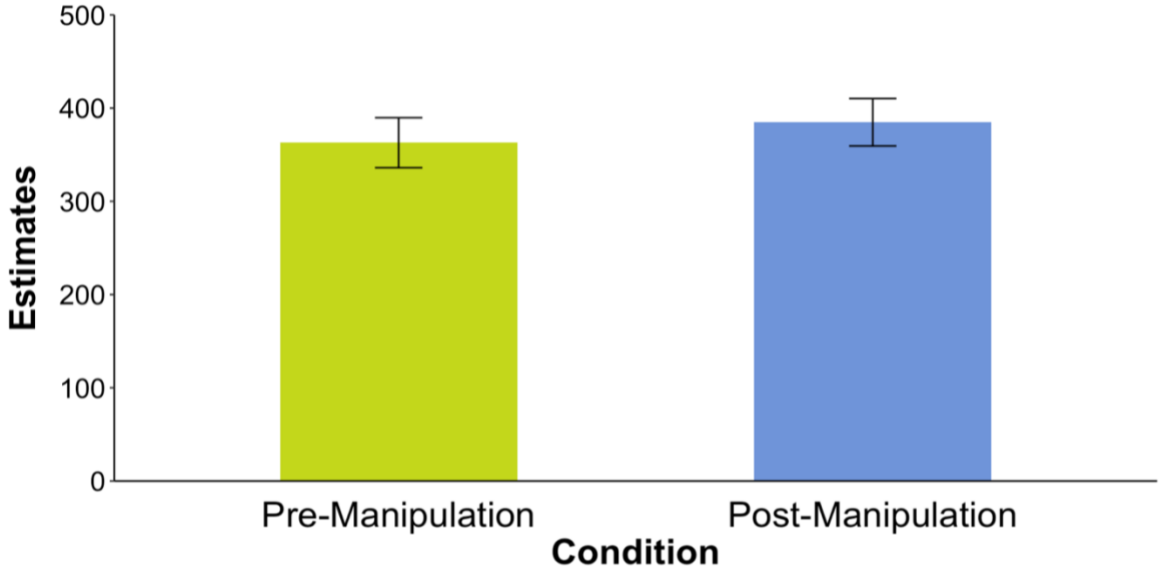
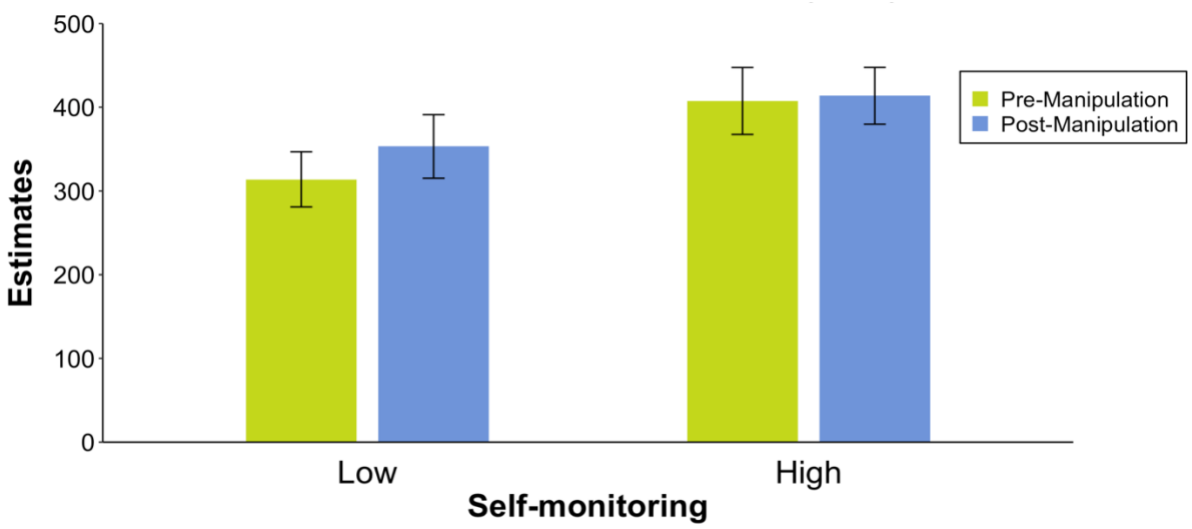


Figure 3K

Barplot depicting the effect of self-monitoring and neutral manipulations on action-effect interval estimates. The error bars represent standard error.



Tables

Table 1A. Descriptive Statistics of Sample 1

Characteristics	N = 39[1]
Age	19.49 (1.71)
Gender	
Female	31 (79%)
Male	8 (21%)
Handed	
Left	4 (10%)
Right	35 (90%)
Race/ethnicity	
Black/African	2 (5.1%)
East Asian	14 (36%)
South Asian	14 (36%)
South East Asian	3 (7.7%)
West Asian or North African	3 (7.7%)
White/European	3 (7.7%)
Racial minority status	
Non-racialized	5 (13%)
Racialized	34 (87%)

[1] Mean (SD); n (%)

This table provides a breakdown of the participants' demographic measures in this research study. Racial minority status summarizes whether participants self-identified as racialized or not.

Table 1B. Manipulation check results

Manipulation Content (N=39)	Acceptance Prime Mean(SD)	Stigma Prime Mean(SD)	Test Statistic	p-value[1]
Stigma	-2.47 (0.57)	2.41 (0.96)	740	<0.001 *** [2]
Emotion	-2.64 (0.49)	2.43 (0.73)	741	<0.001 *** [2]

[1] *p<0.05; **p<0.01; ***p<0.001

[2] Wilcoxon signed rank test with continuity correction

Scores are on a -3 to +3 scale. Wilcoxon ranked sum tests revealed significant differences in the type of content under the two conditions.

Table 1C. Episodic detail questionnaire response summary

Questions (N= 39)	Acceptance Mean(SD)	Stigma Mean(SD)	Test Statistic	p-value[1]
1. How clearly can you visualize this event	4.28 (1.21)	4.56 (1.33)	185	0.3[2]
2. How much did your emotional state change from before the event occurred to after it happened	3.77 (1.25)	4.28 (1.10)	122	0.018 * [2]
3. How personally important IS this event to you NOW	4.15 (1.42)	3.77 (1.63)	1.5	0.2[3]
4. How personally important WAS this event to you THEN	4.56 (1.27)	4.77 (1.27)	102	0.4[2]
5. On average, how often do you think or talk about this event	2.44 (1.37)	2.69 (1.64)	-1.0	0.3[3]
6. Rate the valence of the experience	5.56 (0.64)	2.18 (1.17)	739	<0.001 *** [2]

[1] *p<0.05; **p<0.01; ***p<0.001

[2] Wilcoxon signed rank test with continuity correction

[3] Paired t-test

Wilcoxon Signed-Rank tests on post-manipulation analysis on the racial stigma and acceptance dataset revealed two significant effects: a) on the change in the emotional state changed from before the event to after the event (V = 122, p = 0.02, r=-0.4), and b) change in the valence of participants (V= 703, p<0.01, r= .86). Participants under the stigma condition indicated that they went through a greater emotional change and reported more negative valence, as compared to

the acceptance group. Between the two conditions, there were no significant differences in how participants visualized events (v = 185, p=0.3, r=-0.16), how important they rated the event when it occurred (v= 81, p=0.2, r= -0.2), how important the event is currently (t= 1.5, p=0.15), nor how often participants thought or spoke about the event (t= -1.45, p .32). In sum, the only differences between condition were about valence when recalling the task and how much participants emotion changed during the experience.

Table 1D. Internalized Stigma (Self-Stigma scale response)

Characteristics	N = 32[1]
Affect	1.91 (0.79)
Cognition	1.61 (0.57)
Behaviour	1.27 (0.38)
SSQ composite score	1.60 (0.50)

[1] Mean (SD)

This table provides an overview of participants' responses to the Racial Self-Stigma Scale (Mak & Cheung, 2010). The scale measures three dimensions of self-stigma: affect, cognition, and behaviour. For our study, we explored composite scores.

Table 1E. Big-5 Personality Trait (OCEAN scale response)

Characteristics	N = 39[1]
Openness	37.2 (5.4)
Conscientiousness	32.87 (2.94)
Extraversion	27.10 (2.82)
Agreeableness	29.90 (2.85)
Neuroticism	27.38 (2.43)

[1] Mean (SD)

This table provides an overview of participants' responses to the 5-factors Personality Scale by Goldberg (1993). This scale assesses five dimensions of personality; Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism. For our study, we explored all five dimensions of the scale.

Table 2A. Descriptive statistics of sample 2

Characteristics	N = 123[1]
Age	28 (9)
Gender	
Female	72 (59%)
Male	51 (41%)
Handed	
Right	123 (100%)
Race/ethnicity	
Black/African	19 (15%)
East Asian	56 (46%)
Indigenous	1 (0.8%)
South Asian	25 (20%)
South East Asian	17 (14%)
West Asian or North African	5 (4.1%)
Racial minority status	
Non-racialized	7 (5.7%)
Racialized	116 (94%)

[1] Mean (SD); n (%)

One hundred thirty-two participants partook in the study. During data cleaning, nine participants were removed for failing to report an experience of racial bias and/or acceptance. Data from qualifying participants are included in the table above. Racial minority status refers to participants' self-reported racialized identity.

Table 2B. Manipulation check results for sample 2

Manipulation Content (N=123)	Acceptance Prime Mean(SD)	Bias Prime Mean(SD)	Test Statistic	p-value[1]
Bias	-1.63 (1.95)	1.97 (1.18)	141	<0.001 *** [2]
Emotion	-1.23 (1.71)	1.76 (1.22)	254	<0.001 *** [2]

[1] *p<0.05; **p<0.01; ***p<0.001

[2] Wilcoxon signed rank test with continuity correction

Scores are from a -3 to a +3 scale. Wilcoxon ranked sum tests *revealed significant differences in the type of content under the two conditions.*

Table 2C. *Self-reported episodic detail of racial manipulations* responses

Questions (N= 123)	Acceptance Mean(SD)	Bias Mean(SD)	Test Statistic	p-value[1]
1. How clearly can you visualize this event	4.29 (1.34)	4.31 (1.14)	2,057	0.9[2]
2. How much did your emotional state change from before the event occurred to after it happened	3.72 (1.36)	3.89 (1.18)	1,512	0.2[2]
3. How personally important IS this event to you NOW	3.51 (1.55)	3.25 (1.50)	2,612	0.14[2]
4. How personally important WAS this event to you THEN	4.32 (1.39)	4.54 (1.37)	1,350	0.13[2]
5. On average, how often do you think or talk about this event	2.35 (1.31)	2.34 (1.38)	1,737	0.8[2]
6. Rate the valence of the experience	4.56 (1.58)	2.50 (1.35)	5,474	<0.001 *** [2]

[1] *p<0.05; **p<0.01; ***p<0.001

[2] Wilcoxon signed rank test with continuity correction

Each participant responded to these six questions after each manipulation. Wilcoxon Signed-Rank tests revealed a significant difference between the valence participants reported between conditions (V= 5474, p<0.01, r= .65). Participants reported significantly more negative valence in this bias condition. No other differences were detected.

Table 2D. Internalized Stigma (Self-Stigma scale response)

Characteristics	N = 121[1]
Affect	1.73 (0.65)
Cognition	1.59 (0.59)
Behaviour	1.27 (0.47)
SSQ composite score	1.53 (0.47)

[1] Mean (SD)

This table provides an overview of participants' responses to the Racial Self-Stigma Scale (Mak & Cheung, 2010). A total of 121 participants completed this survey. For our study, we explored composite scores.

Table 2E. Big-5 Personality Trait (OCEAN scale response)

Characteristics	N = 123[1]
Openness	36.0 (5.3)
Conscientiousness	32.7 (3.5)
Extraversion	26.46 (2.80)
Agreeableness	30.06 (2.87)
Neuroticism	26.6 (3.3)

[1] Mean (SD)

This table provides an overview of participants' responses to the 5-factors Personality Scale by Goldberg (1993). A total of 123 participants completed this survey. For our study, we explored all five dimensions of the scale.

Table 3A

Sociodemographic Characteristics of Participants for Study 3A, 3B and 3C

Characteristic	Study 3A: North American sample (N= 45)		Study 3B: International sample (N =44)		Study 3C: North American sample (N=44)	
	n	%	n	%	n	%
Gender						
Female	19	42	30	68	20	45
Male	25	56	14	32	22	50
LGBTQI	1	2.2	0	0	2	4.5
Handedness						
Right	39	87	41	95	43	98
Left	5	11	1	2.3	1	2.3
Ambidextrous	1	2.2	1	2.3	0	0
Racial Minority Status [a]						
Racialized	27	60	24	56	37	84
Non-Racialized	15	33	14	33	4	9.1
N/A	3	6.7	5	12	3	6.8
Race						
Black/African	7	16	26	59	7	16
East Asian	10	22	1	2.3	12	12
Indigenous	0	0	1	2.3	0	0
Latin, South or Central American	5	11	2	4.5	0	0
South Asian	10	22	3	6.8	9	20
Southeast Asian	1	2.2	1	2.3	10	23
West Asian or North African	4	8.9	1	2.3	5	11
White or Caucasian	0	0	5	11	1	2.3
Mixed	8	18	4	9.1	0	

Note. These figures represent the samples prior to any data cleaning.

[a] *Racial minority status refers to participants self-reported racialized identity.*

Table 3B

Descriptive statistics on episodic content of bias-expectation manipulation

Characteristic	N = 44
1. How clearly can you visualize this event, Mean (SD)	4.84 (0.86)
2. How much did your emotional state change from before the event occurred to after it happened, Mean (SD)	3.36 (1.38)
3. How personally important IS this event to you NOW, Mean (SD)	3.05 (1.41)
4. How personally important WAS this event to you THEN, Mean (SD)	4.61 (1.47)
5. On average, how often do you think or talk about this event, Mean (SD)	2.07 (1.39)
6. Rate the valence of the experience, Mean (SD)	2.95 (1.54)

Note: N = 44 reflects the one person was removed for failing to adequality report an experience of bias expectation during the episodic recall manipulation.

Table 3C

Descriptive statistics on coder's analysis of bias-expectation manipulation

Characteristic	N = 44[1]
Bias content	3.84 (1.34)
Negative content	2.82 (1.32)
Positive content	0.81 (1.23)

[1] Mean (SD)

Table 3D

Descriptive statistics summarizing episodic content of bias-expectation manipulation (International sample).

Characteristic	N = 42
1. How clearly can you visualize this event, Mean (SD)	4.98 (1.20)
2. How much did your emotional state change from before the event occurred to after it happened, Mean (SD)	3.26 (1.71)
3. How personally important IS this event to you NOW, Mean (SD)	3.69 (2.01)
4. How personally important WAS this event to you THEN, Mean (SD)	4.57 (1.47)
5. On average, how often do you think or talk about this event, Mean (SD)	2.40 (1.53)
6. Rate the valence of the experience, Mean (SD)	3.05 (1.99)

This table highlights means and standard deviations for each of the 6 questions. The numeric data is formatted so that the Mean is outside of the brackets and standard deviation is inside.

Table 3E

Descriptive statistics on coder's analysis of bias-expectation manipulation

Characteristic	N = 42[1]
Bias content	3.98 (1.44)
Negative content	3.38 (1.63)
Positive content	0.92 (1.49)

[1] Mean (SD)

Table 3F

Episodic content of bias-expectation manipulation from the North American and International samples

Questions (N= 86)	International Mean(SD)	North American Mean(SD)	Test Statistic	p-value
1. How clearly can you visualize this event	4.98 (1.20)	4.84 (0.86)	1050.0000000	0.3[1]
2. How much did your emotional state change from before the event occurred to after it happened	3.26 (1.71)	3.36 (1.38)	-0.3023765	0.8[2]
3. How personally important IS this event to you NOW	3.69 (2.01)	3.05 (1.41)	1.7164821	0.090[2]
4. How personally important WAS this event to you THEN	4.57 (1.47)	4.61 (1.47)	-0.1333905	0.9[2]
5. On average, how often do you think or talk about this event	2.40 (1.53)	2.07 (1.39)	1.0666069	0.3[2]
6. Rate the valence of the experience	3.05 (1.99)	2.95 (1.54)	0.2420277	0.8[2]

[1] Wilcoxon rank sum test

[2] Welch Two Sample t-test

The results of the 2-way mixed ANOVA and t-tests allowed us the confidence to collapse the two datasets and conduct exploratory analyses on the joint dataset (*N*= 88). Henceforth, the rest of the analyses in this section will draw on the joint dataset.

Table 3G

Coder reported details about the content of the bias expectation and neutral manipulations

Manipulation Content (N=136)	Bias Expectation Manipulation Mean(SD)	Neutral Manipulation Mean(SD)	Test Statistic	p-value[1]
Bias expectation content	1.72 (1.86)	0.39 (0.63)	2,907	<0.001[2] ***
Positive emotional content	0.81 (1.33)	1.97 (1.42)	1,059	<0.001[2] ***
Negative emotional content	2.95 (1.57)	1.44 (1.61)	3,061	<0.001[2] ***

[1] *p<0.05; **p<0.01; ***p<0.001

[2] Wilcoxon rank sum test

This table summarizes the paired Wilcoxon rank sum tests to assess differences in content between the bias expectation and the neutral manipulations. The tests revealed significant

differences in bias expectations, positive and negative emotional content between the two conditions.

Table 3H

Descriptive statistics summarizing episodic content of the neutral manipulation (North American sample)

Characteristic	N = 44
1. How clearly can you visualize this event, Mean (SD)	5.00 (0.91)
2. How much did your emotional state change from before the event occurred to after it happened, Mean (SD)	3.09 (1.34)
3. How personally important IS this event to you NOW, Mean (SD)	3.59 (1.65)
4. How personally important WAS this event to you THEN, Mean (SD)	4.07 (1.32)
5. On average, how often do you think or talk about this event, Mean (SD)	3.16 (2.03)
6. Rate the valence of the experience, Mean (SD)	3.95 (1.51)

Table 3I

Post-manipulation episodic detail from the expectation of bias studies and neutral study

Questions (N= 130)	Bias expectation Mean(SD)	Neutral Mean(SD)	Test Statistic	p-value
1. How clearly can you visualize this event	4.91 (1.04)	5.00 (0.91)	1818.0000000	0.7[1]
2. How much did your emotional state change from before the event occurred to after it happened	3.31 (1.54)	3.09 (1.34)	2050.0000000	0.4[1]
3. How personally important IS this event to you NOW	3.36 (1.75)	3.59 (1.65)	-0.7391837	0.5[2]
4. How personally important WAS this event to you THEN	4.59 (1.46)	4.07 (1.32)	2341.5000000	0.023[1]
5. On average, how often do you think or talk about this event	2.23 (1.46)	3.16 (2.03)	1408.5000000	0.013[1]
6. Rate the valence of the experience	3.00 (1.76)	3.95 (1.51)	1259.5000000	0.002[1]

[1] Wilcoxon rank sum test

[2] Welch Two Sample t-test

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