SOCIAL EXCLUSION AND THE SENSE OF AGENCY

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Lay abstract

Psychologists propose that social exclusion threatens some of our most fundamental psychological needs, including the need for sense of control. In the current thesis, we explore the effects of social exclusion on the feeling of control over our actions and the outcomes of those actions, know as the sense of agency. In experiment one and experiment two, we demonstrate, with two different manipulations for social exclusion, that the sense of agency is significantly reduced following social exclusion compared with social inclusion. In experiment three, we show that eating disorders, pathologies characterized in part by chronic social exclusion, are associated with a lower sense of agency compared to healthy controls. Our findings have implications for future work exploring cognitive mechanisms underlying the sense of agency. Additionally, we suggest that intentional binding, an index of the sense of agency, can be used to monitor sense of agency in patients.

Abstract

This thesis explored the effects of social exclusion on the sense of control. We indexed the sense of control using the sense of agency. The sense of agency refers to the feeling of control over our actions and the outcomes of those actions. We experience the sense of agency at an implicit, pre-reflective level. In other words, we routinely make movements that impact some sort of change in the environment, and simply just *know* that our actions cause an effect. Experimentally, we can measure the sense of agency using the intentional binding effect. Intentional binding is a temporal illusion in which we perceive the time between our voluntary action and the outcome of that action to be shorted compared to when the same effect is caused by an involuntary action. We conducted three experiments. In experiment one, we used an episodic memory recall task to prime participants to feel socially excluded or socially included. In experiment two, we used a different manipulation of social exclusion and social inclusion called Cyberball. We found that in both experiments, intentional binding was significantly reduced following social exclusion compared to social inclusion and baseline. In experiment three, we investigated the pre-reflective sense of agency in eating disorders. Eating disorders are highly associated with chronic social exclusion experiences and an altered sense of control in life. We found that individuals with higher eating disorder symptomatology experience a lower sense of agency, compared to healthy individuals. Overall, this thesis is the first to demonstrate that social exclusion has observable effects on the sense of agency. We were able to triangulate these findings using another social exclusion manipulation as well, strengthening our

original findings. Lastly, we showed that a disorder characterized, in part, by social exclusion, reduces the sense of agency.

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Declaration of Academic Achievement

This thesis contains three studies that aim to elucidate the link between social exclusion and the sense of agency. The first chapter summarizes key aspects of the relevant literature and issues that will be addressed in this thesis. I will be the first author on all three studies. Experiment one has already been published. Experiment two and three are being prepared for submission. All three studies have been in collaboration with my supervisor, Dr. Sukhvinder S. Obhi.

Chapter two involves a prime in which participants write about a personal social exclusion and social inclusion experience. This task was conceptualized in collaboration with Dr. Obhi. An intentional binding task was used to obtain the dependent measure. I programmed the task using Superlab. I also collected and analyzed the data. I developed the coding scheme and two undergraduate students coded the primes. I wrote the introduction, methods, results, and discussion. Both Dr. Obhi and I made revisions.

Chapter three involves a different prime in which participants engage in a virtual ball-toss game with other players. Dr. Michael Jenkins programmed the task using MatLab. An intentional binding task was, again, used to obtain the dependent measure. I programmed the task using Superlab. I also collected and analyzed the data. I wrote the introduction, methods, results, and discussion. Both Dr. Obhi and I made revisions.

Chapter four involved using a recent behaviour prime in individuals with self-reported eating disordered behaviour. I conceptualized and designed the prime. The intentional binding task, which I programmed using Superlab, was used to obtain the dependent measure. I collected the data in collaboration with an undergraduate student,

Felicia Chiapetta. I conducted the data analysis. I wrote the introduction, methods, results, and discussion. Both Dr. Obhi and I made revisions.

CHAPTER 1: Introduction to the Sense of Agency and Social Exclusion

General Introduction to the Sense of Agency

Humans are unusual creatures by any stretch of the imagination. Among the billions of living species, we, alone, search for purpose and meaning in our lives. Unlike dancing honeybees, and octopi who die upon procreation, the trajectories of our lives may vary largely depending on our formed beliefs. We spend years of our youths pursuing a "why" for our existence and then a subsequent "how." We decide what our lives will be and then *do* what needs to be done to fulfil our perceived purposes. An indispensable component, then, of being a purposeful being is the capacity to act in accordance with our self-representations, or in other words, to make volitional actions (actions triggered by internal drives/motives rather than by imperative external prompts; Moore and Obhi, 2012). The experience of volitional actions is intricately linked to the sense of agency, or the feeling of control over our voluntary actions and the sensory outcomes of those actions (Moore and Obhi, 2012). We experience the sense of agency in our ordinary lives every time we make a voluntary movement and the effect of the movement is not surprising. For instance, when you walk into a room and make a finger movement to switch on the lights, you experience a sense of control over causing the lights to turn on. We carry out our days with seamless agentic experiences as such. However, if the lights were to remain off even after you flipped the switch to 'on', the action-effect mismatch would produce a disruption in your continuous string of agentic experiences. Similarly, factors such as social context,

individual trait differences, and psychiatric disorders, can alter our agentic experiences (Moore and Obhi, 2012; Malik and Obhi, 2019). Given its pertinence to the human experience, the sense of agency has received considerable attention in the fields of psychology and neuroscience. The following review of the literature sheds light on the advancements made to our knowledge of the sense of agency within the past two decades.

Approaches to Studying the Sense of Agency

The sense of agency refers to the feeling of control over our voluntary actions and the outcomes of those actions (Moore and Obhi, 2012; Obhi and Malik, 2019; Haggard, Clark, and Kalogeras, 2002). A distinction is to be made between the reflective, high-level sense of agency, and the pre-reflective, low-level sense of agency. The reflective sense of agency occurs when we deliberate about the causal link between our voluntary actions and their effects (Malik and Obhi, 2019; Obhi, Swiderski, and Farquhar, 2013). Revisiting the light-switch example from above, the reflective sense of agency would transpire if someone were to ask, "who turned on the lights?" At this instance, we would think about our role in causing change in the environment and perhaps even verbally acknowledge our role. In experimental psychology, the reflective sense of agency is often measured via self-report. In this approach, participants are asked to make a voluntary action to produce an effect, and then use a 7-point Likert scale or a slide-scale to indicate the extent to which they felt their movement had produced the effect. In contrast to this explicit form of agency judgment, the pre-reflective sense of agency involves a "knowing" that our action produced an effect,

without conscious reflection of it (Malik and Obhi, 2019; Obhi, Swiderski, and Farquhar, 2013). We experience the pre-reflective sense of agency routinely in our everyday lives. To study the pre-reflective sense of agency, researchers use a temporal illusion surrounding the experience of voluntary actions, called the "intentional binding effect" (Haggard, Clark, and Kalogeras, 2002; Moore and Obhi, 2002). The intentional binding effect is further detailed in the sections that follow.

Origins of Work on Volitional Action: Intentional Binding

Benjamin Libet and colleagues (1983) pioneered an approach to studying human volition. In their work, they adopted Wilhelm Wundt's century-old complication-clock apparatus to explore the sense of agency using subjective time. In the "Libet clock method" participants sat in front of a clockface marked at regular intervals. A spot revolved around the clockface at a speed of 1 revolution per 2.56 seconds. Participants were instructed to use the clock to judge the onset of events. Judgments were made by reporting the position of the spot on the clockface when they perceived the event. The event was either an intention to make a movement (i.e., the intention to flex their wrist), a movement (i.e., wrist flex), or a stimulus applied to the skin. Results revealed that judgments of movements were slightly early compared to the actual movement onset, whereas judgements of somatosensory stimuli were slightly delayed compared to their actual onset. These findings of discrepant actual onset and perceived onset of action set precedence for future work exploring the sense of agency using subjective time.

In a seminal study, Haggard, Clark, and Kalogeras (2002) used the Libet clock method to investigate the perceived time of actions and their consequent effects. The elegant study consisted of four conditions: two baseline conditions and two operant conditions. In one baseline condition, participants made voluntary actions while they watched a rotating clock hand on a computer screen. They then reported the position of the clock hand when they moved. In the other baseline condition, participants listened for the occurrence of an auditory tone while watching the clock, and reported the position of the clock hand when the tone occurred. In operant conditions, participants made a voluntary keypress on every trial, which produced an auditory tone 250ms later. In one operant block, participants reported the time of their voluntary action. In the other operant block, they reported the time the tone occurred. The main analysis compared the perceived times of actions and tones in baseline conditions to those in operant conditions. Results revealed that, in operant conditions, the perceived time of actions was later than in baseline conditions and the perceived time of tone was earlier than in baseline conditions. In other words, the perceived time interval between voluntary action and the effect of the action in operant conditions was compressed compared to baseline. In a subsequent study, Haggard et al. (2003) induced involuntary movements via transcranial magnetic stimulation over the primary motor cortex. Results revealed that the effect was reversed, such that the perceived time interval between involuntary action and effect increased relative to baseline conditions. These results highlighted that the temporal effect is intrinsically linked to voluntary action, and not to muscle activation or somatosensory feedback. Thus, the 'intentional binding effect' (i.e., the temporal illusion in which the perceived time interval

between a voluntary action and its effect is compressed compared to when the action is involuntary) was first reported.

Basic Conditions for Intentional Binding

Although voluntary action is a necessary condition for binding, further investigations propose that it is not sufficient. Haggard and colleagues (2002) explored the contribution of contiguity and predictability on intentional binding. They used a novel method in which an auditory tone was triggered by either a voluntary finger lift or the offset of a visual stimulus (i.e., a fixation point). A reference visual stimulus, in the form of a flash, was presented at various millisecond intervals before or after the tone. Participants were instructed to report whether the flash and tone occurred simultaneously in each trial. There were four critical conditions in this experiment. In "action-fixed" conditions, the interval between the voluntary finger lift and the tone was always 250ms. In "action-random" conditions, the tone sounded at a random interval between 250–750ms after the finger lift. "No action-fixed" and "no action-random" conditions resembled the "action-fixed" and "action-random" conditions, respectively, except the tone was initiated by the offset of a fixation point rather than by a voluntary action. Thus, the predictability of action outcome, the continuity between action and outcome, and the presence of action were manipulated. Binding was measured by how temporally proximate the flash and the trigger of the tone (i.e., the action or offset of fixation point) needed to be for the tone and flash to be perceived as simultaneous. Results revealed that binding occurred only in action

conditions, with temporally predictable outcomes, and where intervals between action and outcome were short. The authors concluded that voluntary action, predictability, and contiguity are jointly necessary for intentional binding. This apparent dependence on not just action qualities (i.e., voluntariness), but also properties of the action outcome (i.e., predictability and contiguity), gave rise to the link between intentional binding and the sense of agency. As such, the authors speculated that a specific cognitive function of the central nervous system must bind together critical sensorimotor events that surround voluntary action, and that this function may be crucial for the normal experience of agency.

Intentional Binding in Social Contexts

Typically, individuals act in social contexts, rather than in isolation. For example, movers act in concert to carry heavy furniture in and out of homes. Yet, the majority of intentional binding experiments have been conducted in situations where participants act alone. As such, researchers have recently taken interest in exploring the sense of agency, in everyday "joint action" scenarios. Strother, House, and Obhi (2010) conducted the first study examining intentional binding in joint action contexts. Two participants sat side-by-side, each resting their right index finger on a force-sensitive resistor at either end of a spacebar. They were instructed to press the spacebar at a time of their own choosing. They were also told to let their finger move down with key and exert no force when the other person pressed the bar. Using the Libet clock method, intentional binding was assessed in each trial. Explicit judgments of agency were recorded in each trial as well. Results revealed

that even though only the initiator claimed explicit agency for the action effect, intentional binding was indistinguishable for the initiator and passive mover. It was further noted that intentional binding occurred for the passive mover, despite there being no change in the output of the force-sensitive resistor. These results highlight that intentional binding can occur in novel class of action context, "joint action."

Subsequent studies by Obhi and Hall (2011a, 2011b) provide further insight on joint action binding. In the first study, they found that when social role was manipulated, such that one participant was the leader and one was the follower, intentional binding still occurred to similar degrees regardless of discrepant social roles and explicit reports of sense of agency. In the latter study, participants were paired with either a person or a computer. Colour-coded feedback was used to indicate to the participant, at the end of each trial, whether their own action made the tone sound, or whether the other party made the tone sound. Interestingly, they found that when participants were paired with a computer, as opposed to another person, the intentional binding effect disappeared. Even when participants knew that they had caused an effect, as demonstrated by their self-reported sense of agency, no intentional binding occurred on trials in which the computer was indicated as responsible for the tone. The authors propose that when paired with another human, a new "we" identity is formed, with which both partners experience a pre-reflective sense of agency for any action produced by either partner. This identity is not formed when the partner is a machine.

More recently, Pfister, Obhi, Rieger, and Wenke (2014) investigated intentional binding for social action effects. They were interested in elucidating whether different roles

in a social setting could influence perception of actions conducted in this setting. In experiment two, a pair of participants were assigned a role, one being a leader, the other being a follower. The leader was instructed to make a keypress, which, after a variable interval, caused a tone (T1) to occur. The follower was instructed to make a keypress after the tone (T1), which, after a variable interval, produced another tone (T2). In each trial, either the leader or follower made time interval estimates. At the end of each trial, interval estimates were made for one of three intervals: the interval between the leader's keypress and TI (L-ATI), the interval between T1 and the follower's keypress (F-TAI), or the interval between the follower's keypress and T2 (F-ATI). A central finding was that neither the leader nor the follower showed intentional binding for the F-ATI. The authors suggest that the follower did not experience much control over their action and the subsequent effect, which aligns with the notion that causal beliefs influence temporal binding (Moore and Obhi, 2012; Desantis, Roussel, and Waszak, 2011). However, it is unclear why the leader did not show binding between the follower's action and T2, yet did show binding between T1 and the follower's keypress. The authors explain that the temporal interval between the leader's action and T2 was perhaps too long, or alternatively, there were too many events (T1 and follower's keypress) between the leader's keypress and T2.

Causality and Intentionality in Temporal Binding

Some researchers express skepticism about the relationship between temporal binding and intentionality. They suggest that the understanding of a causal link between an

action and its outcome (i.e., causality) is sufficient to produce temporal binding, without the presence of intention behind the action. Suzuki and colleagues (2019) very recently conducted a study to investigate the relative roles of causality and intentionality in temporal binding. In a virtual reality environment, participants made interval estimations between a button press and a tone. There were three conditions in this VR study: active, no hand, and fake. In the active condition, participants made hand movements, which were mimicked in the VR environment, in the form of a button push, causing a tone to sound. In the no hand condition, the button was depressed in the absence of any visible external action. In the fake condition, the participant's previous hand movements were replayed, while the participant made no movement, causing a tone to sound. The authors reasoned that if intentionality was necessary for binding, then interval estimations would be similar in the fake and no hand conditions, and would be significantly longer compared to the active condition. However, since they found that interval estimations were similar in the active and fake conditions, and differed significantly from the no hand condition, the authors concluded that causality, in the absence of an intentional action is sufficient to produce temporal binding.

However, several lines of research highlight the role of intentionality in intentional binding (e.g., Moore, Lagnado, Deal, and Haggard, 2009; Ebert and Wegner, 2010). Recently, for instance, Barlas and Kopp (2018) investigated the effect of congruency between action choice and expected outcome, in an experiment in which participants could choose from up to four voluntary keypresses to make. In a forced choice condition, participants were told by experimenters which key to press. In a free choice condition,

participants chose one key, out of two, three or four keys, to press. The outcome of the key press was either congruent (visually) with the key pressed or incongruent. In all trials of the experiment, the causal link between the action of the participant and the outcome was made apparent. However, action-outcome congruency was variable across trials. Results revealed that both intentional binding and self-reported feeling of control over outcomes were stronger when actions produced congruent, as opposed to incongruent, outcomes. Additionally, intentional binding was enhanced as choice-level increased. These findings underscore the role of intention in intentional binding. As such, a common understanding in the literature is that causality and intentionality are important constituents of the sense of agency.

Neurocognitive Origins of the Sense of Agency

The link between the sense of agency and intentional binding has shed light on the neurocognitive basis for the sense of agency. Traditionally, there are two commonly held positions. The 'predictive' position holds that the sense of agency is generated by processes dedicated to the control of voluntary action. Analogous to the 'comparator model' of motor control (see Blackmore, Wolpert, and Frith, 2002; Blackmore, Frith, and Wolpert, 2006; Moore, Wegner, and Haggard, 2009) the predictive account holds that efference copy of a motor command predicts the sensory consequence of the motor command prior to sensory feedback. If the subsequent sensory feedback matches the internally predicted sensory consequence, then the sensory event is perceived as self-generated and the sense of agency

occurs for the event. If the predicted and actual outcome do not match, then the sensory information is perceived as an external event and no sense of agency is thought to occur (Moore and Haggard, 2008; Sato and Yasuda, 2005; Moore, Wegner, and Haggard, 2009).

The alternative 'retrospective' position holds that the sense of agency is generated by retrospective inference. In this view, an inferential mechanism uses sensory feedback to establish the causal origins of actions and their effects. For example, Wegner's 'theory of apparent mental causation' proposes that the sense of agency emerges when an intention occurs before an action, is consistent with the action, and is the most plausible cause of the action (Wegner, 2003). However, recently, Siadrus, Vuorre, and Haggard (2014, 2017) propose that the predictive and retrospective accounts of agency are essentially equivalent. The prediction versus outcome computation that occurs in the predictive model can really only be done *retrospectively*, after sensory information about the outcome is received. Instead, the authors suggest that a truly 'prospective' contribution to the sense of agency occurs during action selection.

The 'prospective' position holds that the sense of agency can arise prior to knowing action outcomes. On this view, selecting between alternative possible actions itself generates a sense of agency. Chambon and Haggard (2012) used subliminal priming to manipulate fluency of selection between left and right arrow keypresses in response to left- and right-pointing arrow targets. Subliminally primed arrow directions were either identical (compatible condition) or opposite (incompatible condition) to the subsequent target direction. Results revealed that participants reported a stronger sense of agency over a subsequent visual outcome when the prime was congruent with the target, compared to

when the prime was incongruent with the target. Moreover, to mitigate the possibility that the effect was caused by retrospective appraisal of shorter reaction times (to choosing an action) in congruent trials, the authors used a negative compatibility effect (NCE) in priming. With the NCE, they were able to delay the time interval between mask and target; in doing so, an automatic inhibition of an initially-primed response is thought to occur (i.e., slower reaction times at longer NCE latencies). Results revealed that compatible priming enhanced the subjective sense of agency, irrespective of slower response times generated at NCE latencies. Evidence, therefore, suggests that the sense of agency is influenced by action selection, which occurs prior to the action itself.

A current understanding in the field is that these prospective and retrospective cues are integrated to produce the sense of agency. This raises the question of how these cues are integrated. Previous research suggests that a form of Bayesian cue integration is likely. In this framework, prospective and retrospective cues are weighted in terms of their reliability and availability, and then integrated accordingly to produce an optimal cue combination (Moore, Wegner, and Haggard, 2009; Synofzik, Vosgerau, and Voss, 2013). These multiple cues, whether in the form of low-level sensorimotor information or higher-level beliefs, may become available at different times from action intention to action outcome. While these cues may interact in some contexts, they may also make independent contributions to the sense of agency (Sidarus et al. 2017). Additionally, contextual and individual differences can alter the relative weighting of cues. For instance, when an action is involuntary, the absence of prospective cues renders retrospective information about the action outcome to be the most reliable cue, and an external attribution for the cause of the

outcome is made. In contrast, during voluntary actions, highly reliable intrinsic cues are weighted more heavily, and a sense of agency is generated (Moore and Fletcher 2012; Farrer et al. 2013; Synofzik et al. 2013; Chambon et al. 2014). In accordance with this notion, a multi-study investigation, conducted by Sidarus, Vuorre, and Haggard (2017), emphasizes the dominant weighting of prospective cues in producing the sense of agency. Their findings reveal that prospective cues serve as a heuristic cue to estimate agency, learned from everyday life, in which selection fluency depends on individual expertise in a task.

Sense of Agency in Patients

A disordered experience of agency is characteristic of some psychiatric conditions. Given the link between intentional binding and the sense of agency, intentional binding is a promising prospective tool for assessing agency in patients. Symptoms of schizophrenia have been explored extensively using intentional binding. Schizophrenic patients experience 'delusions of control' in which they attribute their actions, speech, and thoughts to external agents. As such, schizophrenic patients report very low levels of agency. The first intentional binding patient study compared the sense of agency in individuals with schizophrenia to healthy controls. Surprisingly, the authors found that intentional binding was significantly stronger in patients with schizophrenia compared to controls. This hyper-binding effect was unexpected given that patients typically report feelings of no control over their actions (Haggard, Flavie, Taylor-Clarke, Jeannerod, and Franck, 2003; Voss *et*

al., 2010). Yet, the effect is robust, and has also been shown in individuals infused with ketamine, compared to controls (Moore, Turner, et al., 2011). Ketamine is an anaesthetic agent shown to induce a state that resembles schizophrenia (Corlett, Honey, Krystal, and Fletcher, 2010). These findings underscore the complex relationship between measures of the pre-reflective and reflective sense of agency. Since this discovery, the intentional binding paradigm has been used to shed light on the neurocognitive basis of an aberrant sense of agency in schizophrenics. Using this paradigm, researches have found that the predictive contribution to sense of agency in schizophrenics is absent (i.e., the patient has the intention to move, and is aware that the action occurred, but is not aware of having initiated the movement.

We propose that future studies can use the intentional binding paradigm to elucidate mechanism underlying abnormal experiences of agency. To date, there are a number of psychiatric conditions that are, at least in part, characterized by an abnormal sense of agency. Some these conditions include depression, anxiety, and eating disorders. Yet, few have been explored in relation to intentional binding. Future research using intentional binding is needed in these areas of study.

Modulators of Intentional Binding and Links to the Sense of Agency

In the past decade or so, research has explored modulators of the sense of agency. Obhi, Swiderski, and Brubacher (2012) used an episodic memory recall task to prime participants to low power and high power states. In the high power condition, participants

wrote about a time they had power over others, whereas participants in the low power condition wrote about a time in which others had power over them. Results revealed that after low-power priming, participants made significantly longer time interval estimates compared to when they were primed to high power or were not primed at all. Using a similar priming technique, Obhi, Swiderski, and Farquhar (2013) investigated the pre-reflective sense of agency during depressive episodes. Participants were asked to recall either memories of depression, events from the previous day, or nothing at all. Compared to previous day-priming and no priming, recalling a depressive episode led to significantly longer action-effect interval estimates. In another study, Hascalovitz and Obhi (2015) used the narcissistic personality inventory to classify participants based on high, middle, and low levels of trait narcissism. They found that individuals with high to middle levels of narcissism made significantly shorter time interval estimates compared to the low narcissism group. These studies highlight that the experience of voluntary action is subject to change depending on idiosyncratic differences and circumstances.

In the current thesis, we are interested in exploring social modulators of self-referential processes. Given the tumultuous political and socio-economical state of affairs, world-wide, we took an interest in investigating social exclusion with respect to sense of agency. In the following section, we provide a brief review of the literature pertaining to social exclusion.

General Introduction to Social Exclusion

Social exclusion is a powerful and ubiquitous phenomenon that affects people all over the world. Whether in the form of ostracism, romantic rejection, being ignored, or being discriminated against, everyone has experienced social exclusion at some point in their life (Williams, 2009). There are several terms that pertain to the experience of being excluded in a social context, including "social exclusion", "ostracism", "social rejection" or simply "exclusion." Although there may be subtle differences in how people understand these terms, they are often used interchangeably in the literature (Abrams, Hogg, & Marques, 2005).

Social exclusion is often linked to cognitive representations of social groups. Such representations can encourage the dehumanization, objectification, and stigmatization of members of various social groups. For instance, Black people in the United States are often represented in mainstream media as violent, gang-involved criminals—a depiction that can serve to exclude them from "mainstream" society (Welch, 2007). Another example of social exclusion at the societal level occurs in India's social caste system, in which the lowest ranked caste, *Dalits*, are considered non-human and impure members of society (Kimmel, Mischkowski, Kitayama, & Uchida, 2017). In Japan, there is a form of schoolyard bullying, called *ijime*; in this form of specific, interpersonal or intragroup exclusion, the bully endeavours to destroy a target child's social bonds with school peers (Akiba, 2004). Such entrenched forms of social exclusion, which have existed for many generations, may be difficult to mitigate.

The consequences of social exclusion are profoundly distressing. Japan is widely recognized as having the highest suicide rate in the industrialized world (WHO, 2015), with *ijime* being one of the contributing factors. The *Dalits* in India are prohibited from access to community services, such as health care, and communal gatherings, such as religious celebrations (Kimmel et al., 2017). In the Unites States, Black men are incarcerated at a disproportionately higher rate than their White counterparts. At the end of 2015, 9.1% of young Black men (ages 20–34) were incarcerated, a rate that is 5.7 times that of young White men (Petit & Skyes, 2017). Additionally, an examination of 15 school shootings in the US implicates "acute or chronic rejection...in the form of ostracism, bullying and/or romantic rejection" as a possible cause in 87% of cases (Leary, Kowalski, Smith, & Phillips, 2003). In 2001, the US Surgeon General's Report on Youth Violence identified social exclusion as the strongest risk factor for adolescent violence, more predictive than poverty, drug use, and gang membership (Twenge, Zhang, Catanese, Dolan-Pascoe, & Baumeister, 2007). As these examples demonstrate, the effects of social exclusion are severe. Investigating the effects of social exclusion on cognition and behaviour has the potential to elucidate approaches to dealing with the adverse consequences of social exclusion.

Temporal Need-Threat Model of Social Exclusion

The Temporal Need–Threat model provides a conceptual framework for understanding the immediate and long-term effects of social exclusion. The model proposes

that the experience of exclusion invokes a sequential three-stage response from the targeted individual—reflexive (or immediate), reflective (or coping), and resignation (or longterm)—with each of these stages associated with specific processes. In the *reflexive* phase, exclusion is felt as social pain and as a threat to four fundamental needs: sense of belonging, self-esteem, sense of control, and sense of meaningful existence (Greenberg, Solomon, & Pyszczynski, 1997; Leary; Williams, 2009; Williams & Nida, 2011). The "social" pain felt in the reflexive stage activates several of the same brain regions associated with physical pain, producing feelings of distress and hurt (Eisenberger, Liberman, & Williams, 2003). During the *reflective* phase, targets reflect on the meaning and relevance of the exclusion event; contextual and individual factors will increase or decrease the target's reaction and desire to cope. The reflective phase concludes with the target thinking and acting so as to bolster the threatened need(s). If exposure to exclusion continues over a long period of time, then the individual's resources for coping are depleted, and they enter the long-term or *resignation* stage. In this stage, the individual is likely to experience chronic feelings of alienation, depression, helplessness, and unworthiness, which may in turn lead to diagnoses of mental illnesses (c.f. Williams, 2009 for an in-depth description of the Temporal Need–Threat model).

Approaches to Studying Social Exclusion

To study the effects of social exclusion, researchers attempt to experimentally manipulate both exclusion and inclusion. For example, Twenge, Baumeister, Tice, and Stucke (2001) had participants briefly interact with a group of confederates that the

participant believed was a group of other participants, under two conditions. In the social exclusion condition, the participant was informed that two of the confederates expressed no interest in working with them in the future. In the social inclusion condition, the participant was informed that two of the confederates did desire to work with them again. Similarly, Williams, and Sommer (1997) invented the "ball toss" paradigm, in which the participant tosses a ball back and forth with two confederates. The participant is led to believe that the confederates are also participants in the experiment. Typically, in a social inclusion condition, the participant and confederates each receive approximately one-third of all ball tosses in the game. In a social exclusion condition, the participant receives a few tosses from confederates in the beginning of the experiment and then receives no, or a disproportionately small number of, tosses for the remainder of the experiment. The ball toss paradigm was later adapted to a computerized version called "Cyberball" (Williams, 2009). In Cyberball, the players are represented by on-screen avatars depicting the participant and two pre-programmed computer players, believed by the participants to be other participants (Williams, 2009). Over recent years, Cyberball has been the most widely used paradigm to induce social exclusion in the laboratory. It has been pivotal in elucidating the affective, cognitive, neural and behavioral effects of exclusion.

The Current Studies

The current thesis presents 3 novel studies exploring the sense of agency and social exclusion. In experiment 1, we explore the effect of recalling a memory of social exclusion on the pre-reflective sense of agency. In experiment 2, we aim to triangulate our results in

the first experiment using a different social exclusion manipulation, the Cyberball paradigm. In experiment 3, we examine the sense of agency in eating disorders, which are characterized, in part, by a distorted sense of control. Chronic social exclusion is thought to play a role in the onset of eating disorders. The implications of these experiments on our current knowledge of the sense of agency and social exclusion will be highlighted in the general discussion.

CHAPTER TWO: Experiment 1 – Social Exclusion Reduces the Sense of Agency:

Evidence from Intentional Binding

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Introduction

In humans, social exclusion is a ubiquitous phenomenon that manifests in various forms across the globe. In Japan, children engage in *ijime*, a form of psychological schoolyard bullying that serves to sever social bonds between the target and their peers (Akiba, 2004). In India, there exists a social caste system, in which the lowest ranked caste, *Dalits*, are largely ignored, and are prohibited from receiving societal services and participating in community events (Kimmel, Mischkowski, Kitayama, & Uchida, 2017). In the UK, lack of access to transportation is a major determinant of the social capital available to individuals (Lucas, 2012). All over the world, but particularly in the West, growing numbers of elderly individuals live in relative isolation and are devoid of the kinds of social connections that contribute to good health (Tomaka, Thompson, & Palacios, 2006). Social exclusion is an all-encompassing term for experiences such as being ignored, rejected, ostracized, and discriminated against (Riva & Eck, 2016; Smith, Morgan, & Monks, 2017; Williams, 2009). Moreover, in an age of flourishing technological innovations, we are

made even more susceptible to antisocial acts via cyberbullying and cyberostracism. Social media provides not only a new platform for relating to others, but also comes with a built-in system for monitoring our online social standing with our peers. For instance, Facebook has a "seen" function that permits you to know when a chat partner has read your message; Mai, Freudenthaler, Schneider, and Vorderer (2015) found that waiting for a response after the "seen" function had indicated that a message had been read could elicit feelings of social exclusion, if the respondents did not answer immediately. Additionally, vicarious ostracism, observing someone else being social excluded by another individual or group, is known to cause observers to feel excluded themselves (Beeney, Franklin, Levy, & Adams, 2011; Masten et al., 2010, 2011, 2013a, 2013b; Meyer et al., 2012; Over & Carpenter, 2009; Wesselmann, Bagg, & Williams, 2009; Will, Crone, Van den Bos, & Güroglu, 2013). Given that social exclusion is a widespread experience, with various guises and increasingly more available avenues for spread, it is important to better understand the cognitive and psychological consequences of social exclusion.

The consequences of chronic experiences of social exclusion are harrowing. Repeated and prolonged exposure to social exclusion depletes an individual's resources for coping, and they enter a state of resignation (Williams, 2009). In this state, the individual is likely to experience alienation, depression, helplessness, and unworthiness (Smith et al., 2017; Williams, 2009). Historically, "resigned" individuals demonstrate a lack of participation in society, high accident rates, homicide, suicide, and affective and psychiatric disorders, including major depressive disorder and eating disorders (Williams & Zadro, 2001; Zadro, Williams, & Richardson, 2004; Zhang et al., 2017). Some of the most vivid

examples of the long-term impacts of social exclusion are the perpetrators of school shootings. An examination of 15 school shootings in the US implicates "acute or chronic rejection… in the form of ostracism, bullying and/or romantic rejection" as a possible causal factor in 87% of cases (Leary, Kowalski, Smith, & Philips, 2003). In light of recent, similar reported occurrences, and the purportedly increasing prevalence of mental illnesses (Vigo, Thornicroft, & Atun, 2016; Weinberger et al., 2018), research on social exclusion is more crucial than ever before. Indeed, research demonstrates that mental illness accounts for one-third of global disability (Vigo et al., 2016; Vos et al., 2015). If in fact social exclusion contributes to such harmful consequences, then examining the causes and consequences of social exclusion has the potential to elucidate approaches to thinking about, and dealing with, social exclusion.

To understand the immediate and long-term effects of social exclusion, Williams (2009) proposed the widely recognized Need-Threat model. The model suggests that each time an exclusionary event is experienced (e.g. at the hands of another individual or group), an individual's sense of belonging, self-esteem, control, and meaningful-existence are threatened (Williams & Nida, 2011; Williams, 2009). As a function of individual differences, and contextual factors, individuals perceive threats to these needs to various degrees. Cognitive appraisal of these threatened needs dictates how one responds to social exclusion behaviourally. Studies have shown that when the need to belong is perceived to be the most threatened, individuals respond to exclusion events with prosocial behaviour as a means to re-establish affiliation with others (Wesselmann, Ren, & Williams, 2015). For instance, experiments reveal that rejected people are shown to attend more to social

information relevant to inclusion (Bernstein, Young, Brown, Sacco, & Claypool, 2008; Pickett, Gardner, & Knowles, 2004), work harder on group tasks (at least among women participants; Williams & Sommer, 1997), focus more on re-inclusion (Maner, DeWall, Baumeister, & Schaller, 2007; Molden, Lucas, Gardner, Dean, & Knowles, 2009; Williams & Nida, 2011), and show increased sensitivity to social influence (Carter-Sowell, Chen, & Williams, 2008; Riva, Williams, Torstrick, & Montali, 2014). They also report increased desires to make new friends and interact with others (Maner et al., 2007), and increasingly display prosocial nonverbal behaviours towards others, such as unconscious mimicry (Lakin & Chartrand, 2003; Lakin, Chartrand, & Arkin, 2008). Conversely, when the need for sense of control over one's environment is perceptually at the most risk, the behavioural response to social exclusion tends to be aggression and a desire to punish others (Twenge, Baumeister, Tice, & Stucke, 2001; Warburton, Williams, & Cairns, 2006; see also Mueller, 1983; Depret & Fiske, 1993; Tedeschi & Felson, 1994; Frieze & Boneva, 2001)

Given the strong links between social exclusion and a reduced sense of control (and the damaging behaviour that can then arise), it is important to more fully understand exactly how social exclusion affects perceived control. One way of addressing this question is to assess how well accepted indices of perceived control are affected by social exclusion. In the context of volitional action (i.e., actions that are internally driven and occur independently of any obvious external stimulus), the perception of control over action has been studied extensively (Haggard, 2008; Moore & Obhi, 2012; Obhi, Swiderski, & Farquhar, 2013). More specifically, the experience of voluntary action is thought to be highly intertwined with one's sense of agency. Sense of agency is best understood as the

feeling of control over one's actions and the effects of those actions (Barlas & Obhi, 2013; Haggard, Clark, & Kalogeras, 2002). This feeling of control is imperative to our sense of ourselves as purposeful, independent organisms (Obhi & Hall, 2011). As essential as the sense of agency is to our everyday lives, we do not routinely engage in cognitive appraisal of our agentic experiences. Rather, when we interact with our surroundings in daily life, we "just know" that our actions change the environment. For example, when I hit a key on a piano, I do not stop to think about my role in causing the resultant auditory sound. However, if someone were to ask "who is playing the piano," I might stop to ponder my role in producing the sound from my key stroke. The kind of agentic experience that we don't reflect upon, is aptly considered to be pre-reflective, and is what we usually conceive as normal agency experience.

One way of studying the sense of agency is to focus on reflective self-report—by asking participants to make actions and then report the degree to which they felt responsible for, or in control of, the resulting outcome (Preston & Newport, 2010; Yomogida et al., 2010). However, given that our routine experiences with voluntary action are not accompanied by conscious reflection, it is difficult to relate research using self-report methods to the pre-reflective sense of agency. Instead, researchers use a different approach to experimentally index the implicit (i.e., pre-reflective) sense of agency. Specifically, researchers assess a temporal illusion that surrounds voluntary action. In particular, when an individual makes a voluntary action that is followed by an effect, such an auditory tone or visual effect, they perceive the time interval between the voluntary action and elicited effect to be shorter than when the same effect is produced by an involuntary action

(Haggard et al., 2002; Haggard, Newman, & Magno, 1999; Strother, House, & Obhi, 2010; Tsakiris & Haggard, 2003). In light of this apparent dependence on volition, the perceived compression of the action-effect interval is referred to as the "intentional binding effect" (see Moore & Obhi, 2012 for a full summary of intentional binding). In the intentional binding paradigm, differences in action-effect interval judgments are thought to reflect varying degrees of pre-reflective agency experience.

Previous research has been instrumental in demonstrating that the sense of agency is indeed linked to perceptual estimates of action-effect intervals. Some research has shown that individuals experiencing pathologies characterized, in part, by an abnormal sense of control, such as schizophrenic patients, judge action-effect intervals to be shorter than healthy controls (Haggard, Martin, Taylor-Clarke, Jeannerod, & Franck, 2003). Furthermore, Obhi et al. (2013) found that activating memories of depression led to longer estimates of the duration between an action and visual effect. Other research has granted support to the agency–intentional binding relationship by experimentally manipulating sense of agency in a healthy population. Obhi, Swiderski, and Brubacher (2012) used an established episodic priming technique (see Galinsky, Gruenfeld, & Magee, 2003) to prime healthy participants to feel powerful or relatively powerless. Compared to a baseline, and no-priming condition, they found that interval estimates were longer when participants felt powerless. Finally, Hascolovitz & Obhi (2015) found that individuals who score high on subclinical narcissism exhibit more intentional binding that those who score low. Taken together, these results support the notion that intentional binding denotes a form of agency experience.

A reduction in sense of agency may be an underlying determinant or modulator of antisocial behaviour following exclusion. If in fact this is true, then in cases where chronic exposure to social exclusion is implicated in clinical pathologies, such as eating disorders and social anxiety disorder, restoring sense of agency may prove to be a fruitful treatment intervention. As such, measures of interval estimates might be a useful tool in clinical settings, for use with patients who suffer from conditions affecting their sense of agency. Specifically, we suggest that interval estimates might be useful for assessing the low-level, pre-reflective sense of agency before, during and after a treatment intervention, with the prediction being that binding would increase (i.e., interval estimates would decrease) after a successful intervention.

In light of these possibilities, the current study sets out to examine the relationship between social exclusion and sense of agency. My specific question is whether feeling socially excluded affects interval estimation; in particular, I assessed whether social exclusion is associated with longer interval estimates compared to social inclusion. To manipulate the sense of social exclusion versus inclusion, healthy participants wrote about a social exclusion episode from their own life ("social exclusion priming"), or they wrote about a social inclusion episode from their own life ("social inclusion priming"), or they did not write about anything ("baseline"), prior to completing an interval estimation task in which they judged intervals between voluntary actions and effects. To the extent that memory of such events reactivates thoughts and emotions from the actual event, such episodic recall has the capacity to put individuals in a personally meaningful state that is very similar to the original experience. Due to the fact that social exclusion is associated

with a perceived loss of control, I predicted that after recalling a social exclusion episode, participants would report action-effect intervals as being longer than in a baseline condition, and a social inclusion priming condition.

Methods

Participants and design

Thirty-six undergraduate students from McMaster University's psychology participant pool (27 females, 9 males), with a mean age of 18.83 (17–27) years, gave informed consent and took part in the experiment for course credit. The study was approved by the McMaster Research Ethics Board (MREB). The experiment was a within-subjects design with three levels of a condition factor: baseline, social exclusion, and social inclusion. The dependent variable was the interval estimation in milliseconds.

Apparatus and stimuli

During the experiment, participants were seated approximately 65 cm in front of a Dell 19-in. LCD computer monitor on which a blank, white screen was displayed. The participants were instructed to press the spacebar with their right index finger, at a time of their own choosing. An occlusion box was placed over participants' hands and the keyboard. The key press was registered by Superlab v4.5 (Cedrus corporationa, CA, USA) software, run on a Lenovo P910 ThinkStation, and caused a single auditory tone (1000 Hz, 100 ms) to sound. Participants were given a pair of sound-cancelling headphones that were plugged into the ThinkStation, through which they heard the tone. The interval between the participant's key press and the onset of the auditory tone was either 100, 400, or 700 ms

(Obhi et al., 2012). The intervals were pseudo-randomly selected and equally probable throughout each experimental block. Participants gave verbal reports of the perceived time interval between their key press (i.e., the voluntary action) and the onset of the single auditory tone (i.e., the action outcome).

Priming procedures were carried out via hand-written recollections of social exclusion episode (social exclusion prime), or a social inclusion episode (social inclusion prime). In a baseline condition, participants did not write about anything.

Procedure

Prior to arriving at the lab, participants were led to believe that they had signed up to participate in two separate studies: a "motor control" experiment and a "creative writing" experiment. Upon arrival, the experimenter informed the participants that the creative writing experiment would be completed in chunks in between blocks of the motor control experiment, in order to "save time." Participants first performed a baseline condition of the interval estimation task, followed by either a social inclusion priming block or a social exclusion priming block. The order of social exclusion and social inclusion blocks was counterbalanced across participants. Participants completed a second baseline interval estimation task following a filler task, which was a mundane word search task, for 5 min. The second baseline was run to determine whether interval estimation changed over the course of the experiment.

In all experimental blocks, participants sat in front of a computer monitor. Participants rested their right index finger on the spacebar of the computer keyboard. An

occlusion box was placed over participants' hands and the keyboard to prevent vision of their hand and the keyboard. Before beginning the first block, participants were instructed that their task was to estimate the time interval, in milliseconds, between their key press and the onset of the auditory tone. They were informed that the interval could range between 0 and 999 ms. They were told that the duration of an eye blink is an estimated 300–400 ms. In the experimental blocks (baseline 1, social exclusion priming, baseline 2, social inclusion priming), each trial began with a blank, white, screen. On each trial, participants pressed the spacebar at a time of their own choosing, causing an auditory tone to sound after 100, 400, or 700 ms. Immediately after the presentation of the auditory tone, participants were prompted with the word "Estimate," on the computer screen. At this time, participants verbally reported their perceived action-effect interval estimation, which was recorded by the experimenter. There were 30 trials in each experimental block.
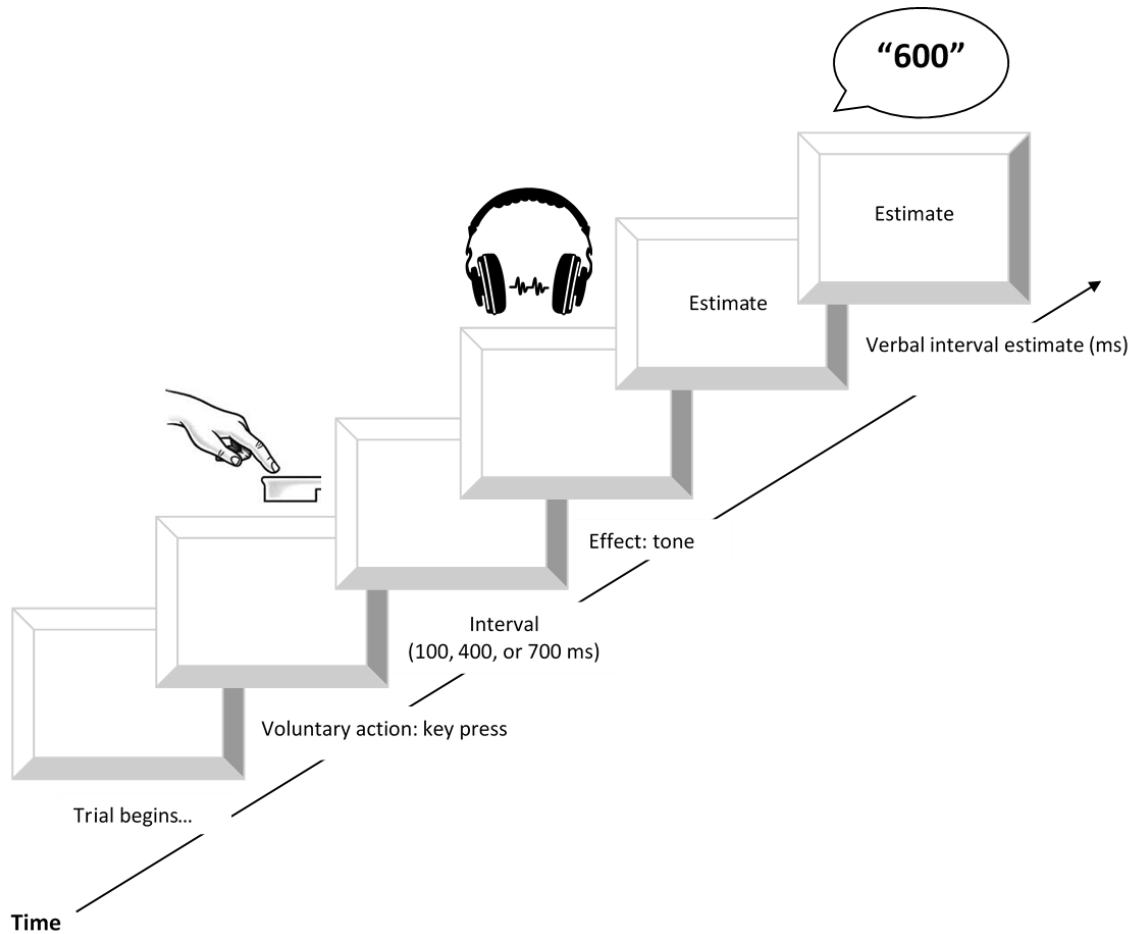
Fig. 1 Trial procedure in the interval estimation task. Participants pressed the spacebar on a computer keyboard at a time of their own choosing which triggered a transition from a blank screen to another blank screen that appeared for an interval of 100, 400, or 700ms. Following the interval, another black screen appeared with the onset of a single auditory tone (1000 Hz, 100ms). Following the offset of the auditory tone, a white screen with the prompt "Estimate" appeared. The prompt remained on-screen until the participant verbally reported the perceived interval between their action and the auditory effect in milliseconds (0-999).

After completing the baseline block, participants were told that they could begin a portion of the writing experiment. At this point, participants engaged in an episodic memory recall task. The experimenter presented participants with an 8×11-in. blank piece of paper. At the top of the paper, there was a prompt asking participants to write about either a time that they felt fully excluded by (social exclusion priming), or fully a part

(social inclusion priming) of, a group of individuals. They were asked to concentrate on the emotions and feelings that were associated with the episode. Half the participants completed the social exclusion priming following the first baseline block, and the other half completed the social inclusion priming following the first baseline block. Following the first prime, participants completed another block of 30 trials, and then were asked to complete a mundane word search task for 5 min. The word search task served as a buffer period to reduce any effects of the first prime from carrying over to the next block. Words in the word search task included non-valenced, mundane words such as "table," "chair," etc. After the word search task, participants completed another baseline block of 30 trials. Participants were then exposed to the other priming task (social exclusion or social inclusion, depending on which one they had not already completed following the first baseline block), and finally completed another 30 trials of the interval estimation task (see Fig. 1.).

Manipulation check

To ensure that the social exclusion and social inclusion episodic memory recall tasks were different in terms of content, off-line coding of the written accounts was performed by two independent coders who were blind to the study hypothesis. The coders used a scale from −3 (no social exclusion content, no emotional content) to +3 (a strong degree of social exclusion content, strong emotional content).

Personality trait measure

At the end of the experiment after all experimental blocks had been completed, participants completed the Big Five Inventory (BFI; John & Srivastava, 1999). The inventory is used, in the general population, to measure one's self-rated extraversion, agreeableness, conscientiousness, neuroticism, and openness. Collection of this data was not directly linked to the current study, but rather, was intended to aid in pilot exploration of the potential link between personality traits and binding. As such, we made no predictions about these potential associations, and data from this instrument will not be reported further in this paper. After completing the inventory, participants were asked if they had any predictions about the purpose and hypotheses of the experiment. Lastly, participants were debriefed and asked to provide written consent for the experimenters to use the data collected.

Control Experiment: Ruling out effects on general time perception

A control experiment was conducted in order to eliminate the possibility that any differences in interval estimation were due to a general effect of social exclusion (inclusion) priming on time perception, rather than the effect of social exclusion on sense of agency. Twelve new participants (ages 17–25) were recruited for this control experiment. All participants engaged in a modified version of the main experiment, in which they judged the time interval between two auditory tones, rather than judging action-effect intervals. The interval between the two tones was either 100, 400 or 700 ms, and each block contained 30 trials. Identical to the main experiment, there was an initial baseline block, social

exclusion block, social inclusion block, and second baseline block, and a mundane word search task.

Results

Outlier exclusion

Action-effect interval estimation was the dependent variable in this experiment. During data processing, interval estimations that were more than 2.5 standard deviations away from the participant's mean estimation for that condition were excluded from further analysis. Overall, $< 0.3\%$ of the data was removed (Obhi, Swiderski, and Brubacher, 2012).

Manipulation check

Each participants' written episodic recollections, for both priming conditions, were coded for social exclusion content and emotional content, by two independent raters. Coders used scales of -3 to $+3$. In assessing emotional content, -3 represented positive emotional content, 0 indicated no emotional content, and $+3$ indicated an abundance of negative emotional content in the essay. In assessing social exclusion content, -3 indicated that the essay contained exclusively social inclusion content, 0 indicated no social inclusion or social exclusion content, and $+3$ represented an abundance of social exclusion content in the essay. Inter-rater correlations were significant for both conditions (social exclusion priming: social exclusion content correlation $= 0.62$, $p < 0.05$; emotional content correlation $= 0.74$, $p < 0.05$; social inclusion priming: social exclusion content correlation $= 0.84$, $p <$

0.05; emotional content correlation = 0.82, p < 0.05). Then, the two sets of rater scores for social exclusion and social inclusion content were averaged and subjected to statistical analysis. Two-tailed student's t tests on this coding data revealed that recollections of a social exclusion episode differed significantly from recollections of the social inclusion episode on both emotional and social exclusion content. In particular, episodic recollections of social exclusion episodes contained more social exclusion content and more emotional content than recollections of social inclusion episodes. This pattern was what we expected from our priming procedure (see Table 1).

Table 1 Mean social exclusion and emotion-related content in recollections of social exclusion episodes and social inclusion episodes.

Content	Social Exclusion Prime	Social Inclusion Prime	*t* test
Social Exclusion	M = 1.78	M = -1.79	*t*(35) = 16.35,
	SD = 0.78	SD = 0.90	*p* < 0.05
Emotional	M = 1.24	M = 0.39	*t*(35) = 2.87,
	SD = 1.06	SD = 1.47	*p* < 0.001

Scores are from a -3 to +3 scale. *t* tests reveal that the recollections differed on both types of content.
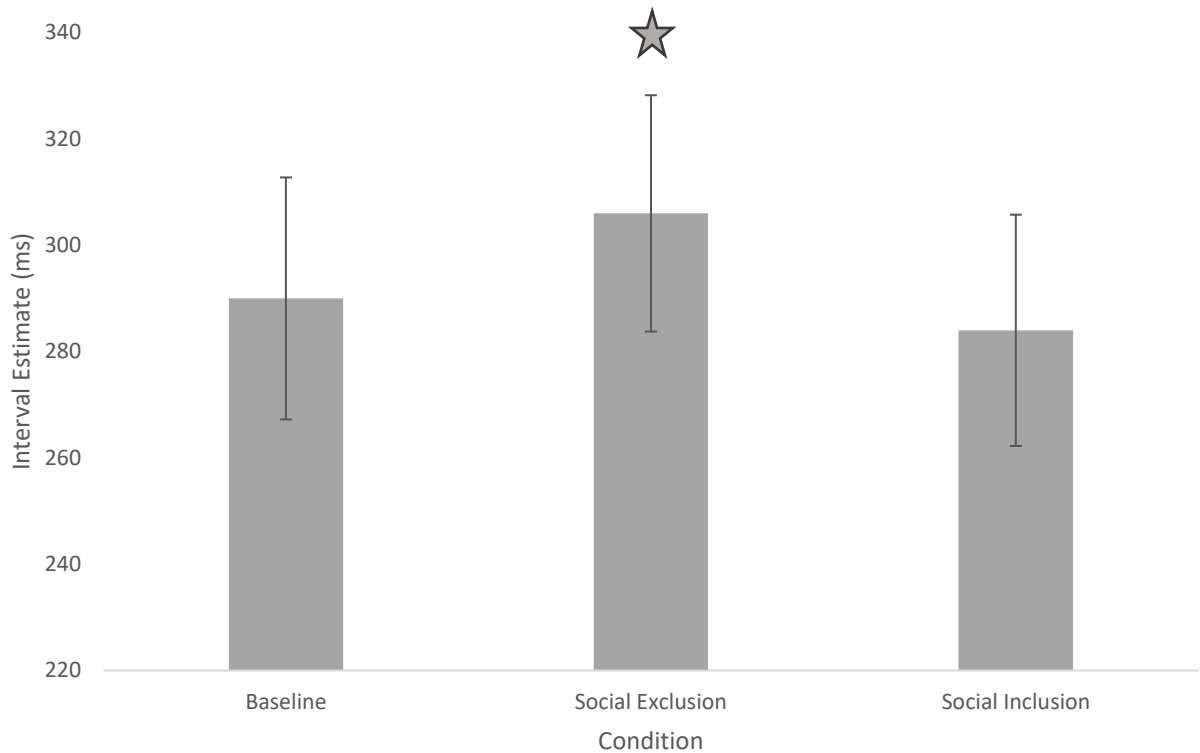
Fig. 2 Mean interval estimates for each of the three experimental conditions. Note that mean estimates were significantly longer after social exclusion priming than after baseline or social inclusion priming (denoted by star, see text for statistics). In contrast, there was no significant difference between interval estimates from social inclusion priming and baseline conditions. *Error bars* are SEM.

Differences in interval estimations across the experimental conditions

For each condition (first baseline, social exclusion priming, second baseline, social inclusion priming), interval estimations were collapsed across the three different (100, 400, and 700 ms) action-effect intervals. Mean interval estimations for each participant in each condition were calculated. A paired, two-tailed t-test demonstrated that there was no significant difference between interval estimations obtained in the first baseline block and

interval estimations obtained in the second baseline block (first baseline condition = 274 ms ± 142 ms, second baseline condition = 306 ms ± 131; t(35) = -1.87, p = 0.07).

Given this, the mean interval estimates for the first and second baseline blocks were averaged, for each participant, to produce a composite baseline mean interval judgement for each participant ("baseline condition" = 290 ms ± 137 ms). The mean judged intervals for each participant were then entered into a repeated measures ANOVA with three levels of the condition factor: baseline (no priming), social exclusion priming, and social inclusion priming. This analysis revealed a main effect of condition (F(2,70) = 4.944, p = 0.01, η_p^2 = 0.12). To test our hypotheses that social exclusion priming would produce longer interval estimates than baseline and social inclusion priming estimates, we conducted a series of one-tailed t tests, using the Holm-Bonferroni correction. As predicted, these tests revealed that the social exclusion condition yielded interval estimates that were significantly longer than the interval estimates obtained in the baseline condition (social exclusion condition = 306 ms ± 133 ms, baseline condition = 290 ms ± 137 ms; t(35) = 2.341, p = 0.013), and the social inclusion condition (social exclusion condition = 306 ms ± 133 ms, social inclusion condition = 284 ms ± 131 ms; t(35) = 2.793, p = 0.004). In contrast, interval estimates in the social inclusion condition did not significantly differ from baseline (social inclusion condition = 284 ms ± 131 ms, baseline condition = 290 ms ± 137 ms; t (35) = 0.722, p = 0.237) (see Fig. 2).

Control Experiment: Ruling out effects of priming on general time perception

In order to check for the possibility that social exclusion priming causes general effects on time perception that could explain our results, we collected data from twelve new participants in a separate experiment (this n was selected on the basis of previous experiments on intentional binding using within subjects designs). For each participant, estimates of tone-tone intervals were entered into a repeated measures ANOVA with three levels of the condition factor (levels: baseline, social exclusion, social inclusion). This analysis revealed no significant effects ($F(2,22) = 0.077$, $p = 0.926$). Thus, the control experiment results suggest that our main findings are not driven by exclusion induced changes on general time perception.

Discussion

The sense of agency is a key aspect of the human experience of volitional action. Experimentally, we can assess an individual's implicit sense of agency by examining perceived action-effect time intervals. A large body of work has suggested that the perceived compression of the time interval between an action and effect (i.e., intentional binding) reflects the sense of agency (Haggard et al., 2002; Moore & Obhi, 2012). The present study used the intentional binding paradigm (specifically the interval estimation version of this paradigm) to investigate whether activating memories of social exclusion alters the perceived time interval between a voluntary action and the consequent auditory tone. Using a within-subjects design, participants were each primed twice with episodic

memory recall tasks. Each participant was asked to write about a personal experience in which they felt excluded by a group or fully a part of a group, in a counterbalanced design. Following each prime, participants engaged in an interval estimation task. Results demonstrated that interval estimates following social exclusion priming were significantly longer than interval estimates following social inclusion priming, and interval estimates obtained prior to priming (i.e., a composite baseline condition made up of data from the two baseline conditions). Implementing social inclusion priming served to rule out any general effects of recalling a personal experience on interval estimation. It also allowed us to isolate the effect of feelings linked to social exclusion on the perception of the action-effect interval.

As confirmed by a manipulation check, the social exclusion and social inclusion recollections, provided by each participant, contained different levels of social exclusion content and negative emotion. In addition to the main experiment, a control experiment was implemented in which participants were asked to judge time intervals between two tones (i.e., a judgement of the interval separating two sensory events with no agentic component). There were no effects of social exclusion priming on this task. This control experiment suggests that our observed effect was not driven by an exclusion-related change in general time perception. A strength of our experiment is that we used a within-subjects design. This approach presumably provides a more conservative test of the effects of activating memories of social exclusion on temporal interval estimation. This is because the effects of each prime type was likely to have had some carry over between experimental blocks which would reduce the differences between conditions.

Although extensive care was taken to control for any alternative causes for the observed effect, other possibilities should still be considered. For instance, differences in cognitive load between conditions was not accounted for – that is, it is unknown whether any participants experienced more cognitive difficulty in recalling an exclusion experience compared to an inclusion experience for example (or vice versa). Having said this, based on previous literature detailing the strong association between social exclusion and perception of control, there is a compelling reason to conclude that the effects found in this study were indeed driven by the social exclusion manipulation. This is the first experiment to my knowledge that makes the direct link between social exclusion and the pre-reflective sense of agency.

Social exclusion is a pervasive human experience. In reflecting on the most painful moments in one's life, events that have threatened our personal health and safety, such as severe physical injury, generally come to mind. However, most of us can also recall an equally painful or distressing experience that did not result in severe physical injury, such as being rejected, ignored, ostracized, or discriminated against. These events of social exclusion are some of our most salient memories because they threaten some of our most fundamental psychological needs, such as the need for belonging, sense of control, self-esteem, and meaningful existence (Baumeister & Leary, 1995; Williams, 2009). But, why should exclusion experiences be so memorable and painful if they present no immediate threat to our health? From an evolutionary perspective, social exclusion increased the chances of death for our ancestors. In an unforgiving environment, our evolutionary ancestors needed access to food, mating opportunities and rearing resources, as well as

safety from predators. These needs were more likely to be met when an individual was part of a social group (MacDonald & Leary, 2005; Tomasello, 2014), and being ostracised from the group literally decreased survival chances (Eisenberger & Lieberman, 2004; Eisenberger, Lieberman, & Williams, 2003; Lieberman, 2013). Thus, it makes sense that humans have developed a profound sensitivity to social exclusion, and that social exclusion is seen as highly threatening. Today, social exclusion remains a threat to humans in the realm of our mental and emotional well-being—components of our being that are critical to our quality of life (Compton & Shim, 2015; Morgan, Burns, Fitzpatrick, Pinfold, & Priebe, 2007).

Repeated experience of being socially excluded is implicated in various mental illnesses, such as major depressive disorders, eating disorders, and anxiety disorders (Zhang et al., 2017). A common notion is that a loss of the sense of control over one's environment may be an immense contributor to the onset of some of these illnesses (e.g., Rosenfield, 1989; Polivy & Herman, 2002). Indeed, research has found that individuals with eating disorders – individuals who report low levels of personal control in their lives (Dalgleish et al., 2001) – show an attentional bias to rejecting faces and this was correlated with adverse childhood experiences with social exclusion (Cardi, Di Matteo, Corfield, & Treasure, 2012). The current results bolster the idea that social exclusion episodes affect one's sense of control, specifically the sense of control over one's actions and the effects of those actions; such a loss is implicated in the onset and maintenance of a range of psychiatric disorders. The results from this study, in conjunction with previous work,

underscore the potential of using intentional binding as a measure of agency in individuals who suffer from an abnormal sense of control.

Clinically, pre-reflective sense of agency could be a useful index of progress, or lack thereof, in patients, pre-, during, and post-treatment. For example, a common treatment practice for individuals with eating disorders is cognitive behavioural therapy (Murphy, Straebler, Cooper, & Fairburn, 2010). The interval estimation task could be administered to patients prior to their first therapeutic session, then again at intermittent times during the treatment process, and lastly, after treatment is completed (Obhi et al., 2013). However, this notion needs to be further investigated in future research. Careful and well-controlled experiments should be conducted on clinically diagnosed participant samples, such as patients with eating disorders. The benefit of such an approach is that it avoids asking patients about the level of control they feel, and as such, avoids issues of social desirability and demand characteristics. Additionally, if we grant that intentional binding as revealed by interval estimates indexes the pre-reflective sense of agency, it would be important to determine whether social exclusion also affects reflective, high-level sense of agency. Future research, using a self-report measure of sense of agency, should be conducted to assess this issue.

In sum, we have shown that recalling a social exclusion episode produces longer action-effect interval estimates than intervals estimated in a baseline condition and intervals estimated after recalling a social inclusion episode. Thus, activating memories of social exclusion affects the subjective experience of time surrounding voluntary action. Our findings support the notion of a relationship between perceived action-effect intervals and

the sense of agency, and also highlight the link between social exclusion and agency-related disorders. Ultimately, more research is needed to further verify the relationship between social exclusion and the sense of agency. Important questions in this regard may relate to identifying the individual difference factors that determine the extent to which social exclusion affects (or does not affect) the sense of agency.

CHAPTER THREE: Experiment 2 - They Didn't Pass to Me: Social Exclusion via

Cyberball Reduces the Sense of Agency

Introduction

As detailed in the previous chapters, social exclusion is a powerful, pervasive phenomenon that affects everyone at some point in their lives. The consequences of social exclusion include atrocious global conditions, such as poverty and world-wide increases in mental illness (Elliott, 2016). As such, studying the causes and consequences of social exclusion can provide valuable insight on how and why it impacts humans to such a vast extent. Within the framework of the Temporal Need-Threat model, psychologists propose that social exclusion elicits an immediate threat to our fundamental needs for sense of control, sense of belonging, self-esteem, and sense of meaningful-existence (Williams, 2009, Williams and Nida, 2011). Using the pre-reflective sense of agency, we can explore the extent to which the sense of control is threatened following an exclusion episode. We can measure the pre-reflective sense of agency using the intentional binding effect (please see Chapter 1 and 2 for detailed descriptions of the intentional binding effect). In Chapter 1 of this thesis, the intentional binding paradigm was paired with a novel social exclusion manipulation to examine the effects of exclusion on the sense of agency. Results revealed that participants made significantly longer action-effect time interval estimates after recalling a social exclusion episode compared to the estimates they made after recalling a social inclusion episode. The current study aims to see whether these results can be triangulated using a different social exclusion manipulation.

A popular approach to manipulating social exclusion in a laboratory setting includes ostracizing participants via a ball-toss game. In this approach, participants are made to believe that they are tossing a ball around with two other participants while they wait for the experimenter to enter the room. In reality, the genuine participant is playing the game with two confederates. The confederates make the participant feel either excluded or included by changing the frequency of throws to the participant. A modern adaptation of the ball-toss game is called Cyberball. In this paradigm, participants are told that they will engage in an online ball-toss game with two other participants in the study. Unbeknownst to the participant, the two other players in the ball game are pre-programmed avatars. In a social exclusion condition, participants are thrown the ball a few times in the beginning of the game and then receive zero throws for the remainder of the game. In the social inclusion condition, participants receive approximately one-third (33%) of the throws, distributed throughout the game. The manipulation is verified with need-threat questionnaires that assess the participant's perceived threat to the sense of belonging, sense of control, self-esteem, and sense of meaningful existence, following each game. Although Cyberball can only manipulate a specific form of social exclusion (in which one individual is excluded by two others), it has been shown to be a reliable method for inducing social exclusion (Williams and Sommer, 1997; Williams, 2009; Williams and Zadro, 2001).

Previously, the Cyberball paradigm has been used to elucidate various social modulators of the immediate effects of social exclusion. For instance, Goodwin, Williams, and Carter-Sowell (2010) demonstrated that attributing social exclusion to membership of a racial group can slow the process of recovering from an exclusion episode. When

participants were excluded by members of another race, via Cyberball, they reported feeling more distressed minutes after exclusion, compared to participants that were excluded by members of their own race. The researchers suggested that when participants attributed exclusion to racial prejudice, their recovery from the episode was impeded, perhaps due to rumination of racism. Recently, von Mohr, Kirsch, and Fotopoulou (2017) used Cyberball to study the effects of social support after exclusion. They used embodied social support as a comparable measure. Following Cyberball-induced exclusion, participants received either slow or fast brushstrokes to their left forearms. Results showed that participants in the slow brushstroke condition reported significantly lower total need-threat than participants in the fast brushstroke condition. The authors suggest that tactile feedback plays an important role in forming social bonds in mammals. Specifically, slow, affective touches, such as gentle strokes, are used to convey positive social intentions, compared to faster-paced touches. These findings provide some of the first evidence that social support, specifically in the form of physical affection, helps mitigate the negative effects of social exclusion.

The current study examines the relationship between social exclusion and the pre-reflective sense of agency using the Cyberball manipulation. To our knowledge, this will be the first study to combine the Cyberball and intentional binding paradigms. It is hypothesized that a social exclusion experience, induced via Cyberball, will lead participants to make relatively longer time interval estimates in the intentional binding task. A social inclusion experience, induced via Cyberball, is expected to lead to shorter time interval estimates in comparison.

Methods

Participants and Design

Thirty-six participants were recruited via McMaster University's psychology participant pool and the general McMaster community. This sample size was determined based on previous studies with similar designs (see Malik and Obhi, 2019; Obhi, Swiderski, and Brubacher, 2013). 26 female and 10 male participants, with a mean age of 24.61 years, gave informed consent and received either course credit or ten dollars. The study was approved by the McMaster Research Ethics Board (MREB). The experiment was a within-subjects design with three levels of a condition factor: baseline, social exclusion, and social inclusion. The dependent variable was the interval estimation in milliseconds.

Apparatus and stimuli

Participants completed the intentional binding task, in which they sat approximately 65cm in front of a Dell 19-inch LCD computer monitor. Each trial of the task began with the monitor displaying a blank, white screen. Participants were instructed to press the spacebar with their right index finger, at a time of their own choosing. An occlusion box was placed over the participants' hands and the keyboard. The keypress was registered by Superlab v4.5 (Cedrus corporation, CA, USA) software, run on a Lenovo P910 ThinkStation. After the keypress, following an interval of 100, 400, or 700 ms (Obhi, Swiderski, and Brubacher, 2012; Malik and Obhi, 2019), a single auditory tone (1000 HZ, 100ms) was produced. The intervals were pseudo-randomly selected by Superlab and

equally probable throughout each experimental block. Participants were given a pair of sound-cancelling headphones that were plugged into the ThinkStation, through which they heard the tone. Prompted with the word "ESTIMATE" on screen, participants gave verbal estimates of the perceived time interval between their key press (i.e., voluntary action) and the onset of tone (i.e., effect; please see fig 1. for a visual representation of trial structure).

The Cyberball Paradigm (Williams, 2009) was used to prime participants to feel socially excluded in one condition and socially included in another condition. Participants sat approximately 65cm in front of a Dell 19-inch LCD computer monitor and engaged in a virtual ball-toss game, programmed via MATLAB. Three identical faceless avatars were used to represent the participant and the two other players in the game. Participant were led to believe that the two other players were "two other participants in the study." The two other players always appeared as the same sex as the participant to avoid any effects of sex. The participant's avatar was displayed at the bottom of the screen, while the other two avatars appeared on the upper right side and the upper left side of the screen. Participants were instructed to choose to throw the ball to one of the two "other participants" upon receiving possession of the ball. They used the right arrow key, on a standard keyboard, to throw the ball to the player on the right and the left arrow key to throw the ball to the player on the left (please see fig 3. for a visual representation of Cyberball task). Each game lasted approximately 3 minutes and consisted of 60 throws. In the social inclusion condition, participants received 33% of the throws, equally distributed throughout the game. In the social exclusion condition, participants received 3 throws in the beginning of the game, and

then received none of the throws for the remainder of the game. In the baseline condition,

participants did not undergo any priming procedures.
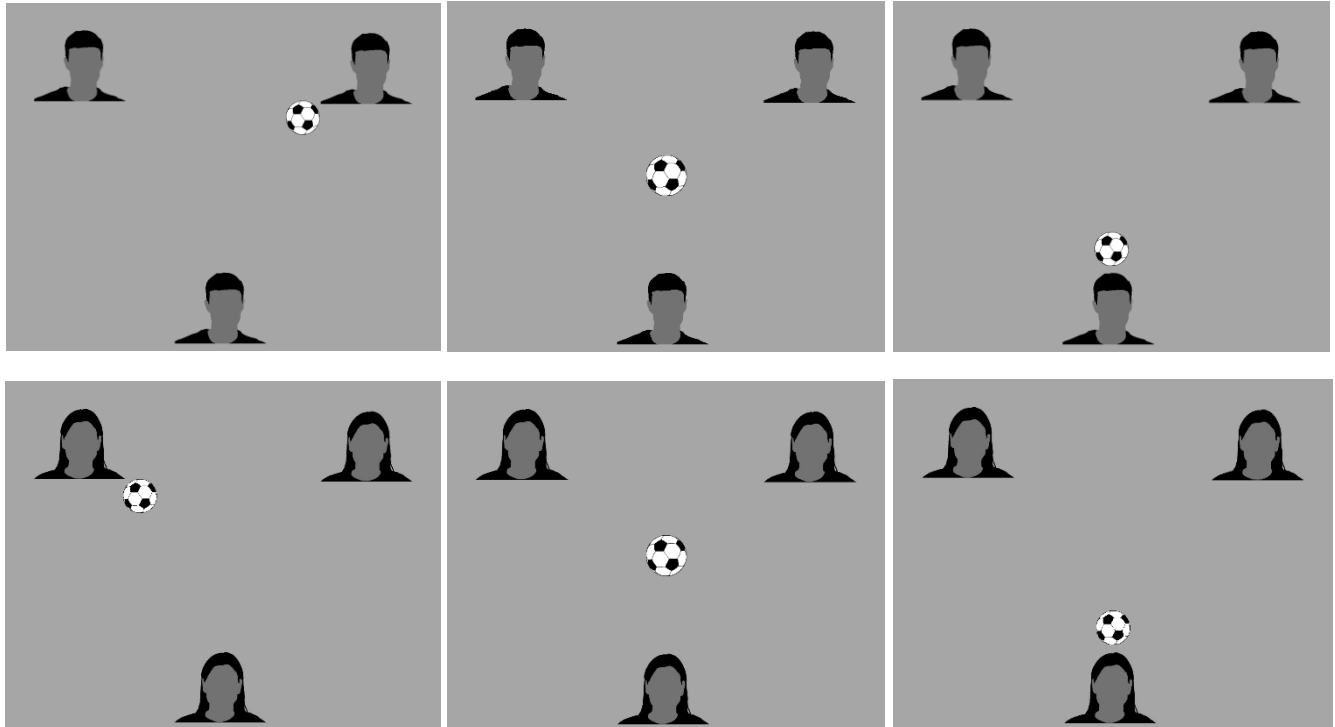
Fig. 3. Cyberball task. Top row. A typical trial in the Cyberball game in which the player on the right throws the ball to the participant. Each time the ball is thrown, it is brought back to the centre of the screen prior to appearing beside an avatar. Male participants played with male avatars. Bottom row. A typical, for a female participant, in which the player on the left passes the ball to the participant.

Procedure

Prior to arriving to the lab, participants were to led to believe that they had signed

up to participate in an experiment investigating the effect of a "repetitive group task" on

"time perception." Participants first performed a baseline block of the interval estimation

task, followed by either a social exclusion priming block or a social inclusion priming block. There were 30 trials in each experimental block. The experimenter sat perpendicular to the participant and recorded the estimates for each trial. The order of the social exclusion and social inclusion blocks was counterbalanced across participants. Participants completed a filler task, which was a mundane word search for 5 minutes, between the two conditions to reduce any carryover effects.

Following the baseline block, participants were told they would engage in a "repetitive group task." At this point they were either socially excluded or socially included via the Cyberball game. Half of the participants were primed to feel excluded first (i.e., they received a few throws at the beginning of the game and then none during the remainder of the game), while the other half was made to feel included first (i.e., they received 33% of the throws, distributed throughout the game). Following the first Cyberball game, participants completed another 30 trials of the intentional binding task. They then were asked to complete a mundane word search for 5 minutes. The word search served to reduce any effects of the first prime from carrying over to the next block. Words in the word search task included non-valenced, mundane words, such as "chair," "computer," etc. After administering the word search for 5 minutes, participants completed the second priming task, which could have been social exclusion or social inclusion via Cyberball. Following the second prime, participants completed the final 30 trials of the interval estimation task. Participants then completed 2 need-threat questionnaires. Lastly, participants were debriefed and asked to provide written re-consent.

Manipulation check

To ensure that our social exclusion and social inclusion manipulations were effective, need-threat surveys were administered at the end of the experiment. The need-threat questionnaires contain 23 items to assess how threatened participants felt their needs for belonging, self-esteem, sense of control, and sense of meaningful existence were following each Cyberball game. The questionnaire also asked participant to indicate to what extent they felt ostracized and to estimate the percentage of throws they received in each condition. The need-threat questionnaire was administered twice, one for each time the game was played.

Personality Trait Measure

At the end of the experiment, participants also completed the Big Five Inventory (BFI; John & Srivastava, 1999). The inventory is used, in the general population, to measure one's subjective extraversion, agreeableness, conscientiousness, neuroticism, and openness. Collection of this data was intended to aid in exploring the potential link between personality traits and intentional binding. As such, we did not make any predictions regarding these potential associations.[1]

Results

Outlier Exclusion

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[1] We did not find any significant correlations between personality traits and interval estimates, thus we will not discuss these results further.

Action-effect interval estimation was the dependent variable in this experiment. For each condition, interval estimations that were more than 2.5 standard deviations away from the participants' means were excluded from further data analysis. Less than 0.01% of the data was removed.

Manipulation Check

Each participant completed a need-threat questionnaire for both priming conditions. There were significant differences between reported need-threat between the social exclusion and social inclusion conditions (social exclusion=5.41, social inclusion=2.30, $t(35)=11.62$, $p<0.001$). Additionally, participants reported receiving a significantly lower percentage of throws in the social exclusion condition compared to the social inclusion condition (social exclusion=9.03%, social inclusion=46.44%, $t(35)=9.45$, $p<0.001$). Lastly, on a scale of 1–10, participants reported a significantly greater level of ostracism in the social exclusion condition compared to the social inclusion condition (social exclusion=9.31, social inclusion=2.58, $t(35)=22.82$, $p<0.001$). This pattern was expected from the priming procedure.

Differences in interval estimations following social exclusion and inclusion

Interval estimations were collapsed across the three different action-effect intervals (100, 400, 700 ms), for each condition (baseline, social exclusion, and social inclusion). Mean interval estimates in each condition were calculated for each participant. These mean interval estimates were then entered into a repeated measures ANOVA with three levels of

the condition factor: baseline, social exclusion, and social inclusion. The analysis revealed a significant main effect of condition (F(2,70)=3.42, p=0.038, $\eta p^2 = 0.08$).

We hypothesized that social exclusion priming, via Cyberball, would lead to a reduction in intentional binding, and social inclusion priming would lead to an increase in intentional binding. To test our prediction, we conducted a series of one-tailed, student t-tests, and used Holms-Bonferroni to correct for multiple comparisons. As predicted, social exclusion yielded significantly longer time interval estimates compared to social inclusion (social exclusion condition = 351.13 ± 150 ms, social inclusion condition = 329.43 ± 140 ms; t(35) = 2.085, p = 0.02), and baseline (social exclusion condition = 351.13 ± 150 ms, baseline condition = 308.63 ± 142 ms; t(35) = 2.247, p = 0.02). However, interval estimates following social inclusion did not significantly differ from interval estimates taken at baseline (social inclusion condition = 329.43 ± 140 ms, baseline condition = 308.63 ± 142 ms; t(35) = 1.152, p = 0.129).
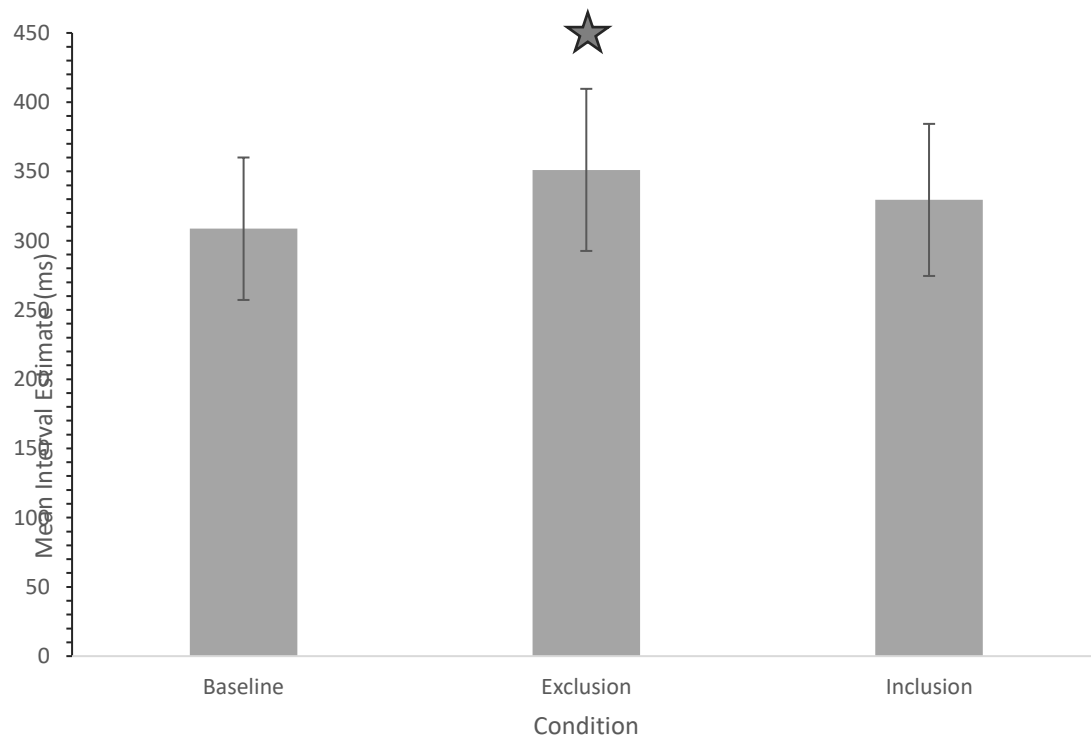
Fig 4. Mean interval estimates for each of the three experimental conditions. Note that mean estimates were significantly longer after social exclusion priming than after baseline or social inclusion priming (denoted by star, see text for statistics). In contrast, there was no significant difference between interval estimates from social inclusion priming and baseline conditions. *Error bars* are SEM.

Order effects: social exclusion following social inclusion

As a secondary analysis of the data, we looked at differences between participants who completed the social exclusion prime prior to the social inclusion prime versus those who underwent social inclusion prior to the social exclusion, using the Holms-Bonferroni correction. We found that the subset of participants who were socially included first and then excluded demonstrated significant differences between interval estimates in the social exclusion and social inclusion conditions (social exclusion=345.39, social inclusion=313.40, $t(17)= 2.58$, $p=0.012$). Conversely, participants who were socially

excluded first, and then re-included, did not demonstrate significant differences between interval estimates in the social exclusion and social inclusion conditions (social exclusion=360.11, social inclusion=354.62, $t(17)$= 0.30, p=0.77). Therefore, the effect of condition seems to be greater when inclusion occurs prior to social exclusion. Additionally, after correcting for multiple comparisons with Holms-Bonferroni (α=0.0167), there was no significant difference between the baseline block compared to the social exclusion condition, when participants were excluded prior to being included (baseline= 306.49, social exclusion=360.11, $t(17)$=2.06, p=0.03). There was also no significant difference between the baseline block and social exclusion, when inclusion occurred first (baseline= 221.67, social exclusion=345.39, $t(17)$=0.90, p=0.38).
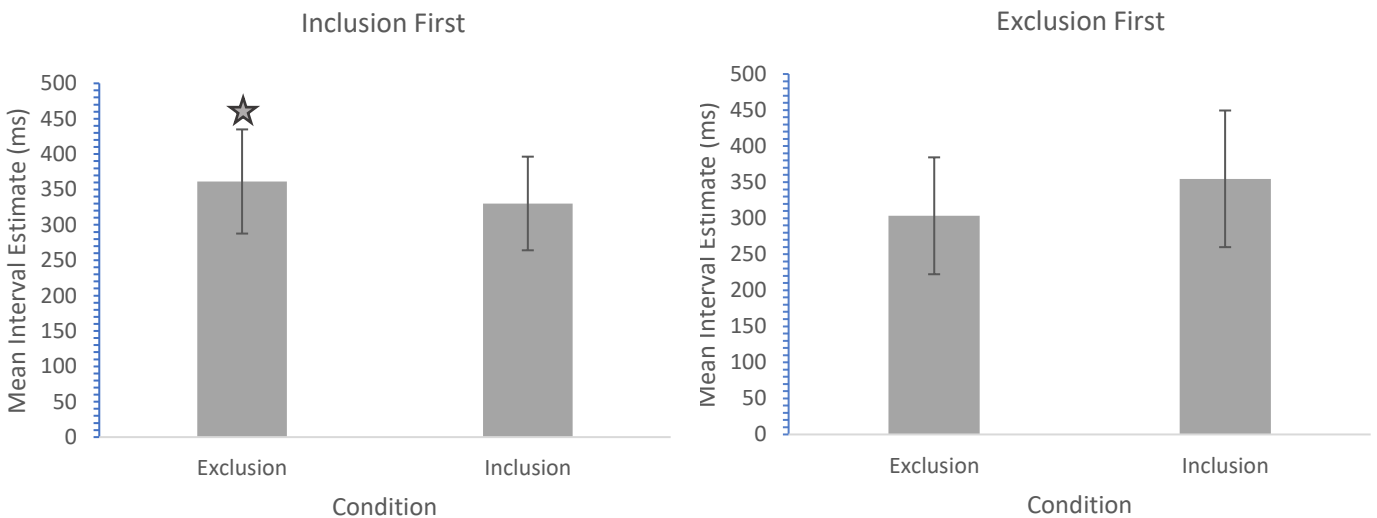
Fig 5. Differences in interval estimates based on order of condition. Left. There was a significant difference between time interval estimates in the social exclusion condition versus the social inclusion condition when participants were included prior to being excluded. Right. There was no significant difference between time interval estimates when participants were excluded prior to being included. *Error bars* are SEM.

Discussion

Feeling purposeful and impactful is inextricably linked to the sense of agency in human beings. When we choose to act, we expect outcomes to our actions. When those outcomes match the intended effect of our movements, we experience the sense of agency (i.e., a sense of feeling of control over our actions and the outcomes of those actions). In our everyday lives, we experience the sense of agency at a pre-reflective level, not often reflecting on the causal link between our actions and their effects. In the current study we set out to investigate the pre-reflective sense of agency after social exclusion. We used the well-established intentional binding paradigm to obtain interval judgments between a keypress (i.e., a voluntary action) and a tone (i.e., an effect). Intentional binding occurs when a participant estimates their action-effect time intervals to be relatively short. A reduction in the intentional binding effect indicates a reduction in the pre-reflective sense of agency. We predicted that the sense of agency would be reduced following social exclusion, compared to social inclusion and baseline.

In a with-in subjects design, we manipulated social exclusion using the Cyberball paradigm. As confirmed by our manipulation check, participants experienced significantly greater need-threat following social exclusion compared to following social inclusion. Participants completed 30 trials of the interval estimation task in each condition. Results revealed that participants made significantly longer time interval estimates following social exclusion via Cyberball, compared to social inclusion via Cyberball, and baseline. Social inclusion priming was implemented to rule out the general effects of an online ball-throwing game on time interval estimation between action and effect. It also served to

isolate the effect of feelings linked to social exclusion on the perception of action-effect time intervals. These results are consistent with previous work demonstrating the effects of social exclusion on the pre-reflective sense of agency (see Malik & Obhi, 2019).

A secondary analysis was conducted in which participants were divided into two groups: those who underwent the social exclusion condition first and those who underwent the social inclusion condition first. The purpose of this analysis was to explore whether the order in which exclusion and inclusion occur can have an influence on the sense of agency. Results reveal that when participants were socially included via Cyberball and then subsequently excluded via Cyberball, they experienced a significant reduction in intentional binding compared to those who were first excluded and then included. Presumably, in the former case, participants expected to be included in the second round of the ball game, based on their prior experience with the game. Exclusion, then, elicits a greater violation to the participants' expectations of inclusion, leading to a greater effect of the exclusion prime. Future research using neuroimaging techniques, such as ERPs, should investigate neural responses to exclusion following inclusion and vice versa.

Although care was taken to control for alternative causes for the observed effect, there were a few methodological limitations to the study. First, cognitive fatigue between participants could not be controlled for. Additionally, participants may differ in terms of their experiences with social exclusion. Research suggests that chronic social exclusion reduces one's sensitivity to future exclusion episodes (Williams, 2009). As such, desensitized individuals may not show observable differences in intentional binding between the two conditions. However, previous literature that details the strong association

between social exclusion and perception of control provides compelling reason to conclude that the effects found were indeed driven by the social exclusion manipulation.

The results of the current study support the notion that social exclusion is a powerful phenomenon. Social exclusion has the power to reduce our most fundamental psychological needs, one of these needs being a need for sense of control. Combining the Cyberball paradigm with intentional binding, for the first time, this study demonstrates that social exclusion reduces our sense of control over our actions and the outcomes of those actions. The implications of these findings are profound. Previous work demonstrates that the loss of sense of control, following social exclusion, is implicated in subsequent aggressive and antisocial behaviour by the excluded individual (Twenge, Baumeister, Tice, & Stucke, 2001; Warburton, Williams, & Cairns, 2006). Additionally, repeated exposure to social exclusion is implicated in various psychiatric disorders, such as eating disorders, schizophrenia, and major depressive disorder (Zhang et al., 2017).

Further exploration of the neural mechanisms involved in the reduction of the sense of agency following social exclusion can provide insight on mechanisms underlying deleterious cognitive or affective consequences. For example, research demonstrates that inducing disbelief in free-will affects low-level motor preparation of voluntary actions (Rigoni, Kuhn, Sartori, and Brass, 2011). Using ERPs, the study showed that an early readiness potential (early-RP), preceding voluntary action, is attenuated in participants who had disbelief in free-will compared to those who had belief in free will. The authors suggest that the early-RP is modulated by the level of intentional involvement of the participant.

Disbelief in free will depletes participants' intentional involvement in the preparation of voluntary motor actions. We suggest that a similar mechanism could be responsible for the results demonstrated in the current study. When an individual is excluded, they may experience a disbelief in their abilities to willfully affect change in the environment, and as such demonstrate a decrease in early-RP amplitude prior to voluntary action execution. This attenuation in early-RP may affect prospective processes underlying the sense of agency (Vercillo, O'Neil, and Jiang, 2018), such as selection fluency. It could be the case that, in a state of tentativeness or behavioural inhibition, initiating a voluntary action is adversely affected. It could also be that the process of initiating a voluntary action is extended over a long time period due to the requirement to let motor activation build to some threshold. Perhaps this extension in time could make it difficult for people to judge the onset of their action. Future research is needed to specify the mechanisms involved in the reduction of the sense of agency following social exclusion.

CHAPTER FOUR: Experiment 3 - The Pre-reflective Sense of Agency is Reduced in

Eating Disorders: A Study Using Intentional Binding

Introduction

The previous two chapters demonstrated the effect of social exclusion on intentional binding. We found that recalling a social exclusion memory, and feeling excluded via Cyberball, significantly reduces intentional binding compared to social inclusion. In this chapter, we explore intentional binding in eating disorders, a pathology highly linked to chronic experiences of social exclusion and an altered sense of agency.

In the past decade, the intentional binding paradigm has been used to investigate pathologies characterized, in part, by an abnormal sense of agency. In particular, there has been a growing interest in assessing the congruency between explicit, self-reported experiences of agency and implicit, pre-reflective experiences of agency in these affected populations. Such assessments have the potential to elucidate the neural and motor mechanisms underlying the sense of agency. Individuals with Schizophrenia, for instance, experience delusions of control, in which they report that their actions, thoughts, speech, and/or emotions are made for them by an external agent. Using the intentional binding paradigm, Haggard, Martin, Taylor-Clarke, Jeannerod, and Franck (2003) demonstrated that intentional binding was significantly stronger in patients with schizophrenia as compared to a healthy control group. This striking result set precedence for further investigations that have shed light onto the mechanisms responsible for this dissociation between the pre-reflective and reflective sense of agency in schizophrenics (c.f. Synofzik,

Thier, Leube, Schlotterbeck, & Lindner, 2010; Voss et al., 2010; Maeda et al., 2013; Graham-Schmidt, Martin-Iverson, Waters, 2018 for more details). Similarly, individuals with Autism Spectrum Disorder (ASD) experience impaired self-referential processing, such as incorrectly attributing the effect of their own actions to another agent (David et al., 2008). A study conducted by Sperduti, Pieron, Laboyer, and Zalla (2014) aimed to discover whether this altered sense of agency also exists at the pre-reflective level in individuals with ASD. Results reveled that when the effect was a visual cue, patients with ASD made significantly longer action-effect interval estimates compared to a typically-developing control group. In contrast to the case of schizophrenics, individuals with ASD do not experience a dissociation between the reflective and pre-reflective sense of agency. These results highlight the utility of intentional binding in exploring sense of agency in disorders where there are deficits in performance or experience of willed action.

With the ever-increasing prevalence of eating disorders worldwide (Galmiche, Dechelotte, Lambert, and Tavolacci, 2019) psychologists continue to develop a more nuanced understanding of eating disorder symptomatology. As such, the role of sense of agency in the onset and maintenance of eating disorder symptoms has been highlighted by researchers (Latzer and Stein, 2019; Ferguson and Mendelsohn, 2011). Researchers propose that eating disorders function as a means to restore a loss of sense of agency. When an individual experiences psychotic levels of helplessness over events in their life, whether in the context of familial relations or other social contexts, they may try to subconsciously counteract these feelings by exerting control over their eating behaviours (Seeman, 2014, Yamashita, Takei, Kawai, and Nori, 1999; Rudd and Lennon, 2000; Jarman, Smith, and

Walsh, 1997). Self-report measures of agency support this notion. Bers, Blatt, and Dolinsky (2004) took open-ended self-descriptions from 15 women with anorexia nervosa, 15 women with other psychiatric disorders, and 48 non-patients. They found that the descriptions provided by the patients with anorexia expressed a significantly lower sense of agency and harsher reflectivity compared to non-patients. Similarly, Dalgleish and colleagues (2001) used self-report measures to examine perceived control over events in the world. They found that when depression levels were covaried out, anorexic and bulimic patients perceived themselves as having significantly less personal control over events in the world, relative to non-patient participants.

Broadly, eating disorders are characterized by a persistent disturbance of eating or eating-related behaviour that results in the altered consumption or absorption of food and that significantly impairs physical or psychosocial functioning (DSM-5). Anorexia Nervosa (AN) and Bulimia Nervosa (BN) are the two most widely studied types of eating disorders. AN is characterized by restrictive food intake, intense fear of weight gain, and a disturbance in the way in which one's body weight or shape is experienced. Individuals with AN typically engage in starvation and purging, and sit at a below-normal BMI. The self-esteem and sense of control of these individuals is highly dependent on their perceptions of body shape and weight. They have strong desires to control their environment and often experience anxiety, increased sensitivity to social exclusion, and obsessive tendencies with respect to eating. BN is characterized by recurrent episodes of binge eating and inappropriate compensatory behaviours to prevent weight gain, as well as self-evaluation that is tied to body shape and weight. Individuals with BN experience an extreme loss of

sense of control and guilt/shame following an episode of binging. They are typically normal to over-weight and experience symptoms of mood or anxiety disorders. Despite differences in symptomatology, both disorders are characterized by extreme, repetitive behaviours surrounding the feeling of control.

Kristmannsdottir, Keski-Rahkonen, and Kuusinen (2019) conducted a study suggesting that the sense of agency changes in accordance with the specific eating disorder symptoms experienced by the patient. Individuals with eating disorders experience and interpret their emotions as linked to their eating behaviours. It is difficult for them to relate their emotions to events outside of their eating disorder. As such, we propose that there are 4 phases that an eating disorder patient can exist in with respect to their symptoms and sense of agency. A patient is in the "restraint" phase when they limit their food and calorie intake. During this time, they experience a strong sense of agency with respect to their symptoms. An individual in the 'binge' phase has recently consumed a subjectively excess amount of food in a short amount of time. The binge phase is associated with feelings of loss of control over eating and extreme guilt. In this phase, the patient experiences a low sense of agency. The binge phase is generally short-lived and followed by a compensatory behaviour. The compensatory behaviour is often in the form of self-induced vomiting, excessive laxative use, and/or excessive exercise. At this point, the patient is in the "purge" phase and experiences a rise in, or nascent, sense of agency. Lastly, individuals may experience a transient "fed" phase after having consumed a subjectively appropriate amount of food/calories. This phase is thought to be associated with a stable sense of agency.
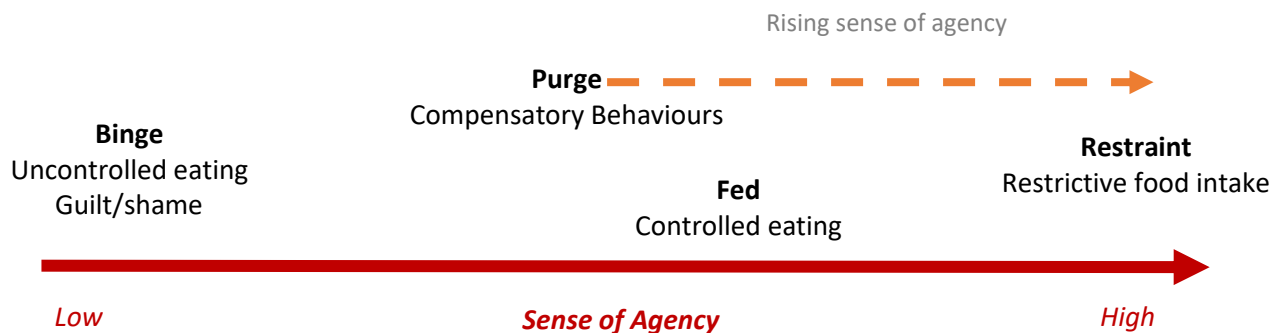
Fig 6. Proposed relationship between eating disorder phases and the sense of agency.

In light of these recent insights, the current study set out to further investigate the sense of agency in relation to eating disorder symptomatology. In particular, we were interested in exploring the pre-reflective sense of agency in each of the phases: restraint, binge, purge, and fed. We expected to see congruency between the reflective reports of agency within these stages, as detailed from previous work (e.g., Kristmannsdottir, Keski-Rahkonen, and Kuusinen 2019), and the pre-reflective measure of agency. In the current study, we worked with a subclinical population of individuals with self-reported experiences of disordered eating. We used a priming task to gauge the phase each participant displayed at the time of their participation. We hypothesized that those in the 'binge' phase would demonstrate the lowest sense of agency, as indexed by weak intentional binding in the interval estimation task. Participants in the 'restraint' phase were expected to show strong intentional binding and sense of agency. Participants in the 'purge' and 'fed' phases were expected to show intermediate levels of intentional binding. As a

secondary hypothesis, we proposed that higher degrees of eating disordered behaviours and attitudes (as indexed by a series of questionnaires) would result in weaker intentional binding across all participants.

Methods

Participants and Design

Eighty-two undergraduate students from McMaster's psychology participant pool (76 females), with a mean age of 19.54 years, gave informed consent and took part in the experiment for course credit. This sample size was based on a power analysis (~80% power) using G*Power 3.1.9.2 (Faul et al., 2007). The study was advertised to individuals who answered "Yes" to the pre-screen question "Do you think you have an eating disorder?" The study was approved by the McMaster Research Ethics Board (MREB). The experiment was a between-subjects design. The dependent variable, obtained via the intentional binding task, was interval estimation (in milliseconds).

Apparatus and Stimuli

The intentional binding task required participants to be seated approximately 65 cm in front of a Dell 19-in. LCD computer monitor on which a blank, white screen was displayed. Participants were instructed to press the spacebar with their right index finger, at a time of their own choosing. An occlusion box was placed over participants' hands and the keyboard. The key press was registered by Superlab v4.5 (Cedrus corporationa, CA,

USA) software, run on a Lenovo P910 ThinkStation, and caused a single auditory tone (1000 Hz, 100 ms) to sound. Participants were given a pair of sound-cancelling headphones that were plugged into the ThinkStation, through which they heard the tone. The interval between the participant's keypress and the onset of the auditory tone was either 100, 400, or 700 ms (Obhi et al., 2012). The intervals were pseudo-randomly selected and equally probable throughout each experimental block. Participants verbally reported the perceived time interval between their key press (i.e., the voluntary action) and the onset of the single auditory tone (i.e., the action outcome) in each trial of the task (please see fig 1. for trial structure of the intentional binding task). Hand-written responses to six questions regarding eating-related behaviour within the last 24 hours was used to prime current stage in binge-purge-starvation cycle. Based on their responses, participants were categorized into one of four conditions: binged, purged, starved, fed (see Appendix for all six questions).

Subjective Measures

Three questionnaires were used to measure eating disorder symptomatology. The Eating Disorder Examination Questionnaire (EDE-Q) is a self-report tool used to measure cognitions and behaviour regarding eating and body image, with subscales: eating concerns, shape concern, weight concern, and restrained eating. The EDE-Q has acceptable psychometric properties (e.g. Peterson et al., 2007), including internal consistencies (Cronbach's alpha) of 0.90 for the total scale and 0.70–0.83 for the four individual subscales. Questions are scored 0–6, with higher scores indicating greater eating disorder pathology (Fairburn, 2008; Fairburn & Cooper, 1993). The Eating Attitudes Test (EAT-26) is a 26-item self-report measure of the symptoms of Anorexia Nervosa, with high reliability

and validity (Garner, Olmsted, Bohr, & Garfinkel, 1982; Lee et al., 2002; Mintz & O'Halloran, 2010). Scores greater than 20 indicate a need for further assessment by a qualified medical professional. The Body Shape Questionnaire (BSQ-34) is a 34-item self-report measure of concerns about body image (Cooper et al., 1987). Higher scores reflect body shape concerns characteristic of anorexia nervosa and bulimia nervosa. Lastly, participants completed the Big Five Inventory (BFI; John & Srivastava, 1999). The inventory is used, in the general population, to measure one's self-rated extraversion, agreeableness, conscientiousness, neuroticism, and openness.

Procedure

Prior to arriving to the lab, participants were led to believe that they had signed up for an eating disorders and 'motor control' experiment. Due to the partial deception used, written consent was collected from participants at the beginning of the experiment and following the debrief at the end of the study.

Participants first performed a baseline block of the interval estimation task (please see the methods section in Chapters 2 and 3 for a detailed account of the interval estimation task). They were then primed to think about their most recent eating behaviour (i.e., binging, purging, starving, or fed) by writing responses to six eating-related questions on an 8 x 11-inch piece of paper. Directly following the prime, participants completed another block of the interval estimation task. Self-report measures were administered at the end of the experiment. In total, all participants completed 60 trials of the interval estimation task;

30 trials were completed prior to administering the prime and 30 trials were completed post-prime.

Data Analysis

Manipulation Check

Two independent coders, who were blind to the study hypothesis, were recruited to assess the written recent behaviour primes. Questions 1–5 were used to categorize participants into one of four recent behaviour groups: binged, purged, restraint, fed. These groups were used later in the main analysis. Question 6 was judged on two affective dimensions (sense of guilt and sense of control), and two behavioural dimensions (restraint and compensatory behaviour). Coders used scales of -3 to +3, where -3 indicated extreme guilt, no sense of control, extreme compensatory behaviour, and extreme restraint, and +3 indicated no guilt, complete sense of control, and no indication of compensatory behaviour and/or restraint.

Outlier Exclusion

Action-effect interval estimation was the dependent variable in this experiment. During data processing, interval estimates that were more than 2.5 standard deviations away from the participant's mean estimation for that condition were excluded from further analysis. Overall, less than 0.1% of the data was removed.

Principle Component Analysis of Subjective Measures

A principle component analysis (PCA) of the subjective measures was performed to reduce dimensionality and address multicollinearity in the data. The PCA produced 11 principal components. Based on scree plot, the first 6 components were extracted, which accounted for 86% of the total combined variance of all 11 principle components (Fig 7a). A principle component regression was performed and confirmed that retaining the first six principal components produces the lowest cross-validation error, measured in mean squared error of prediction (MESP; Fig 7b). Therefore, a six component solution maximizes model prediction performance.

The six principle components were interpreted based on the correlations (factor loadings) with the original 11 variables (Table 2). The first principle component, interpreted as "Body Image Disturbance", has large positive associations with the BSQ-34 and trait levels of neuroticism. The second principle component, interpreted as "Weight Control", has large positive associations with the EAT-26 and weight control behaviours, as indexed by the weight concern subscale of the EDE-Q. The third principle component, interpreted as "Eating Control", has strong positive associations with the EAT-26 and restrictive food intake behaviours, as indexed by the restraint subscale of the EDE-Q. The fourth, fifth, and sixth component principals were interpreted as "Preoccupation with food", "Weight Gain Fear", and "Shape Concern", respectively. A varimax rotation was applied,

transforming these components into six independent, orthogonal components. These six components were later entered into a standard regression model, as predictors, to analyze the relation between subjective measures and sense of agency (as indexed by mean interval estimates, averaged across pre- and post-prime).

		PCA Factor Loadings (varimax rotated)					
Original Variables	Mean (st.dev)	PC1 "Body Image Disturbance"	PC2 "Weight Control" (behavioural)	PC3 "Eating Control" (behavioural)	PC4 "Preoccupation with food"	PC5 "Weight Gain Fear"	PC6 "Shape Concern"
BSQ-34	117.26 (39.76)	**0.41**	-0.02	-0.03	0.10	-0.24	-0.14
EAT-26	24.12 (14.86)	-0.06	**0.39**	**0.41**	**0.44**	-0.39	-0.50
EDE-Q Restraint	2.75 (1.67)	0.09	-0.68	**0.67**	-0.11	0.14	-0.11
EDE-Q Eating Concern	2.24 (1.54)	-0.06	-0.15	0.04	**0.82**	0.16	0.50
EDE-Q Weight Concern	3.71 (1.56)	0.09	**0.55**	0.47	-0.09	**0.60**	0.11
EDE-Q Shape Concern	3.33 (1.55)	0.10	0.22	0.30	-0.28	-0.50	**0.66**
BFI-Extraversion	23.56 (6.92)	-0.30	-0.02	0.21	-0.07	-0.26	0.06
BFI-Agreeableness	34.96 (5.84)	0.05	-0.13	0.12	0.09	-0.27	0.02
BFI-Conscientiousness	30.54 (5.69)	-0.13	0.02	0.04	-0.03	0.02	-0.04
BFI-Neuroticism	28.78 (6.12)	**0.60**	-0.02	-0.07	0.07	-0.04	0.08
BFI-Openness	32.84 (6.25)	-0.57	-0.05	-0.03	-0.02	-0.04	0.07
% Total Variance		42%	14%	11%	8%	6%	5%

Table 2. Six principal components were extracted, accounting for 86% of the variance of the original 11 subjective measures. Each component reflects a linear combination of all original measures. For each original variable, the highest factor loadings are represented in bold. Based on factor loadings, the principal components were interpreted. Components were made orthogonal using varimax rotation.

a) **Scree Plot**

b) **Average**
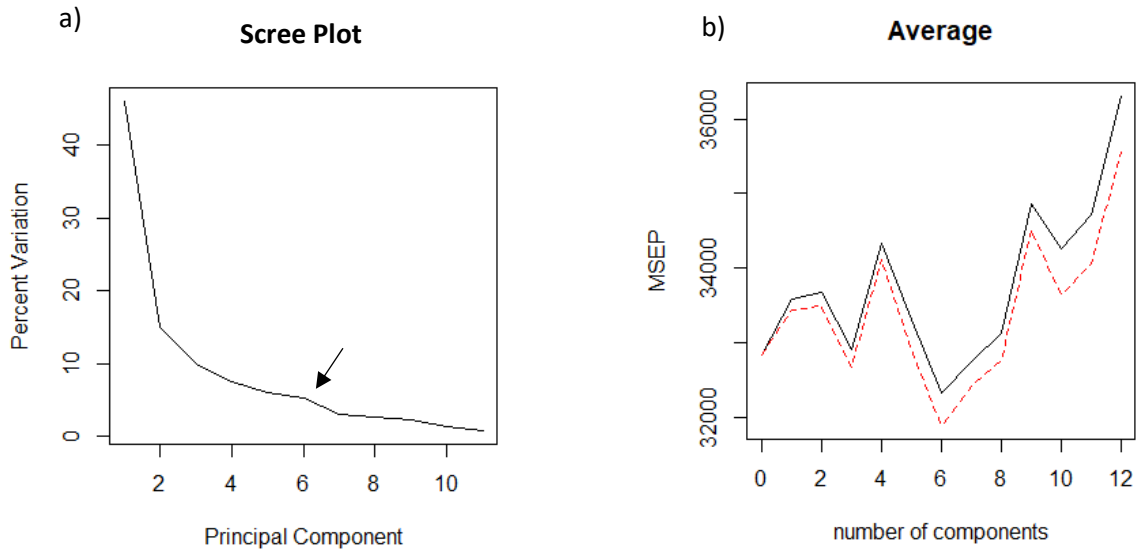
Fig 7. a) Scree plot. Scree plots are used to determine the number of principal components to retain. Six components were considered acceptable based on drastic slope change indicating a drop in the percent variation accounted for by factors 7–11. b) Principal component regression confirmed, via lowest cross-validation error, that a six component solution was optimal.

Results

Manipulation Check

Each participants' written prime responses were coded by two independent raters on 4 dimensions. Sense of guilt and sense of control were two dimensions used to gauge affective content in the primes. A deep sense of guilt and loss of control are two well-established characteristics of disordered eating (American Psychiatric Association, 2013). In the participant essays, guilt and control were often indicated by statements regarding

food, exercise, and purging. For example, one participant expressed guilt after eating and control after excessive exercise: "I felt guilty after eating the croissant, so I went to the gym to do cardio for 2 hours and then I went swimming for 1.5 hours. After that, I felt like I had control over everything and was able to focus on studying." Coders indexed sense of guilt and control using a scale of -3 (extreme guilt and lack of sense of control) to +3 (no sign of guilt and complete sense of control). Compensatory behaviour and restraint were the other two dimensions, which were used to draw behavioural insight from the primes. Compensatory behaviour was indicated by excessive exercise, laxative use, and self-induced vomiting as a means to compensate for food consumption. Restraint was indicated by intentional, prolonged starvation. Coders used a scale ranging from -3 (extreme compensatory behaviour and extreme restraint) to +3 (no compensatory behaviour, no restraint) to index behavioural components of participant essays. Inter-rater correlations were significant across all dimensions (guilt correlation $= 0.68$, $p < 0.05$; control correlation $= 0.61$, $p < 0.05$; restraint correlation $= 0.83$, $p < 0.05$; compensatory behaviour correlation $= 0.75$, $p < 0.05$).

Participants were grouped based on their most recent eating-related behaviours. Two independent coders used responses to questions 1–5 of the prime to group participants. Inter-rater correlations were significant for grouping (r $= 0.73$, $p < 0.05$). Of the 82 completed primes, 18 were contentious with respect to grouping. These 18 were revisited and discussed by coders until a final group was assigned to each of the 18 participants. Overall, there were 38 participants in the "Fed" group, 17 in the "Binged" group, 14 in the "Restraint" group, and 13 in the "Purged" group.

Differences in Interval Estimates Across Recent Phases

For each condition (pre- and post-priming) interval estimations were collapsed across the three different (100, 400, 700 ms) action-effect intervals. Mean interval estimates were calculated for each participant in each condition. The difference between the pre- and post-condition mean interval estimates were then calculated for each participant (i.e., post-prime mean estimates – pre-prime mean estimates). These difference scores were then compared across the four groups: Binged, Purged, Starved, and Fed. A standard parametric test could not be performed after testing for homogeneity of variance across groups (Bartlett's K-squared = 14.60, p <0.01), and normality (Shapiro-Wilk test: W = 0.71, p <0.01). Instead, the difference scores were entered into a Kruskal-Wallis test. This analysis revealed no significant differences between mean difference scores across groups ($\chi 2$ = 3.03, df = 3, p = 0.39; see fig 8. a)). Since there was no effect of prime, the mean interval estimates were averaged across conditions (i.e., pre- and post-prime) to produce a composite mean interval estimate for each participant. These composite scores were then entered in to a Kruskal-Wallis test; the analysis revealed no significant difference between composite mean interval estimates across groups ($\chi 2$ = 2.78, df = 3, p = 0.43; see fig 8. b)).
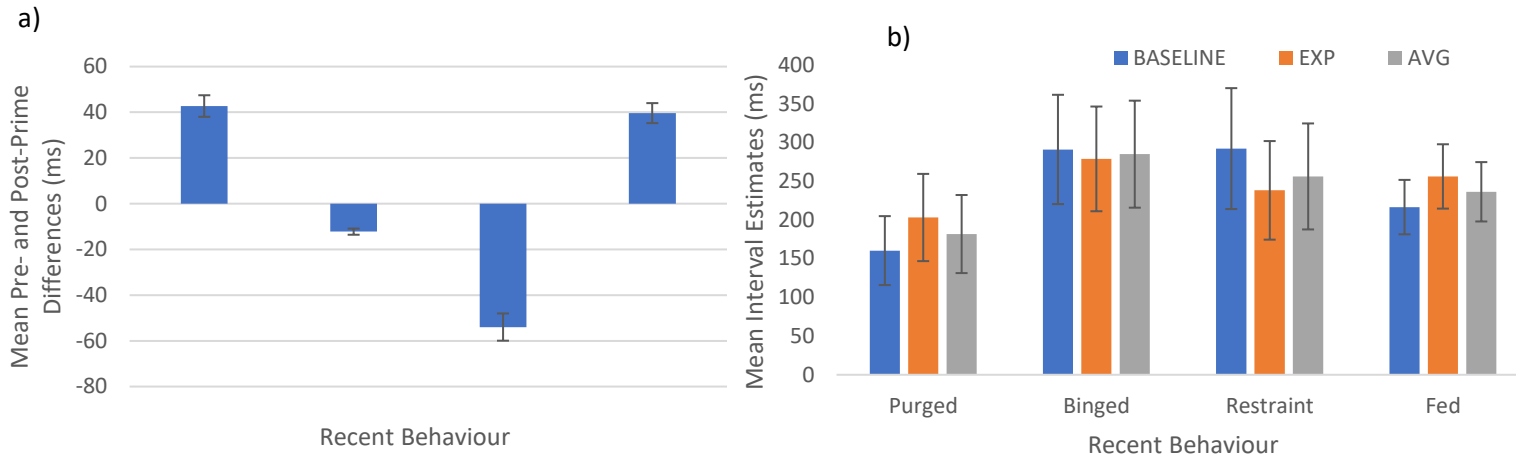
Fig 8. a) Difference in mean Pre- and Post-Prime interval estimates across all four groups. A positive difference is indicative of a decrease in intentional binding and negative difference is indicative of an increase in intentional binding, b) Mean interval estimates in both conditions ("Pre-Prime" and "Post-Prime"), and mean interval estimates averaged across the two conditions ("Average"), for all four groups (Purged, Binged, Restraint, and Fed). *Error bars* are SEM.

Regression with Principle Components

PCA extracted six independent principal components accounting for 86% of the variance of the original 11 subjective measures. To explore the possible relations between sense of agency and eating disorder symptomatology, the six principal components were entered into a standard multiple regression model with mean interval estimates (averaged across both conditions: pre- and post-prime, as there were no significant differences between the two blocks) as the dependent variable. The regression model was significant ($F_{6,75}=2.70$, $R^2= 0.18$, $p=0.019$). Positive relations between subjective measures and interval estimates indicate that the lowest sense of agency (indexed by relatively large interval estimates) was found in individuals who i) exhibited neurotic levels of body image distortion, and ii) have more extreme weight control behaviours and attitudes.

Discussion

The sense of agency is indispensable to the human experience. Volitional actions allow us to feel purposeful and impactful in a world full of ambiguity. We routinely experience the sense of agency on a pre-reflective level. Experimentally, we can assess the pre-reflective sense of agency by examining action-effect time interval judgments. Intentional binding occurs when these time interval judgments between a voluntary action and its effect are relatively short. This temporal compression has been traditionally interpreted as a heightened pre-reflective sense of agency. In the current study, we used the intentional binding paradigm to explore the pre-reflective sense of agency among individuals with disordered eating behaviours.

In this subclinical sample of affected individuals, we gauged eating disorder symptomatology using three well-established questionnaires: EAT-26, BSQ-34, and EDE-Q. Due to the multicollinearity in the data set produced by these measures, each measure could not be used as an independent predictor in a standard multiple regression model. Additionally, combined with the 5 subscales of the BFI, 4 subscales of the EDE-Q, and the remaining two EAT-26 and BSQ-34 scales, 11 subjective measures were used to capture symptomatology and traits in our subclinical population. As such, a principal component analysis (PCA) was authorized to reduce multicollinearity and dimensionality in our data set. The PCA identified 6 orthogonal principal components that adequately represented the original 11 variables. We interpreted the components based on which of the 11 original measures were most accounted for by the component in terms of percent variance explained. These six components were then used as predictors in a standard multiple

regression model. We found that the regression model was significant. Our regression model predicts that higher levels of neuroticism with respect to body image distortion and increased weight control behaviours and attitudes are associated with a lower sense of agency. This result compliments the literature detailing a strong loss of sense of control contributing to the onset and maintenance of eating disorders.

As confirmed by our manipulation check, participants experienced varying levels of loss of control and guilt depending on which phase they were most recently in. This was expected based on previous work detailing changes in sense of agency depending on recent behaviours (Latzer and Stein, 2019). Participants were grouped by most recent behaviour, providing 38 participants in fed, 17 in binged, 14 in restraint, and 13 in purged. Non-homogeneity and non-normality in the sample required a Kruskal-Wallis analysis of variance, which did not yield significant differences between the groups. The limitations of this approach to studying individual eating disorder phases are that 1) random group assignment is not possible, and 2) non-clinical participants may experience binging and purging as well. Additionally, some participants detailed their experience of an older, rather than their most recent, behaviour in question 6 of the prime. This caused some ambiguity regarding group assignment among the two coders.

Our results have important implications in the treatment of individuals with eating disorders. Currently, there is no clear consensus on the best treatment approach to eating disorders (Linardon, Fairburn, Fitzsimmons-Craft, Wilfley, & Brennan, 2017; Steinert, Munder, Rabung, Hoyer & Leichsenring, 2017). Much of the contention surrounding treatment in the literature can be attributed to a novel insight about the nature of eating

disorders: if eating disorder behaviour serves to restore a lost sense of control in life, then treatment presents a threat to this control. This means that successful treatment would need to find the patient an outlet for control outside of their eating behaviours. However, in order to make changes to their eating behaviours, patients need to feel agentic in their capacity to act in a healthy manner, but this agency is only derived from unhealthy behaviours. A paradox is presented here: a high sense of agency is a prerequisite for treatment, yet sense of agency is highly dependent on the disordered eating. As such, past research has produced little empirical direction on how to strengthen the sense of agency during psychotherapy (William & Lewitt, 2007).

Novel approaches to the treatment of eating disorders have begun to explore ways to enhance the sense of agency in order for patients to obtain the capacity for reflection and change in symptomatic behaviour and thinking. MANTRA (Maudsley Anorexia Nervosa Treatment for Adults; Latzer and Stein, 2019) is a new cognitive motivation-based psychotherapy that aims to increase motivation for change and focuses on addressing reasons for the patient's willingness to remain ill. The treatment aims to externalize the eating disorder (i.e., separate the individual from the eating disorder symptoms) so that the patient can envision and work towards finding control and meaning outside of their disordered behaviours. Similarly, "Zeida Laderech" is a novel Israeli model for treatment based on fostering a sense of autonomy outside of the eating disorder. Quintessential to these approaches is nurturing a sense of agency and then rechannelling the sense of agency to aspects of the patient's life outside of the eating disorder (Latzer and Stein, 2019).

We propose that these models for treatment can be optimized by timing therapeutic interventions with high agency moments. In the initial stages of treatment, the sense of agency derived from disordered eating can be used to guide the direction of psychotherapy. Although we were unable to demonstrate it in our study, we suspect that the sense of agency is rather volatile, and changes depending on the phase in which the patient is in. For instance, a patient may arrive for psychotherapy after having binged only hours prior. During the session then, the patient may be experiencing a low sense of agency and therefore lack the mental/emotional integrity to make healthy behavioural changes. As such, the psychotherapist can opt to focus on a psychoeducation, which may require less flexibility and motivation for change on the patient's part.

Implementing this agency-level based strategy would always require the psychotherapist to be attuned to the patient's sense of agency. This can be accomplished by asking the patient to detail their experiences as the beginning of each treatment session. However, this method is subject to self-report biases. As such, we propose that intentional binding is a more reliable tool for clinically gauging the sense of agency in patients with eating disorders. Intentional binding can be administered as a standard test to patients prior to therapy sessions. The medical professional can then use this information to tailor the session to the patient's present sense of agency. On high agency days, psychologists may find it acceptable to advocate for changes to the patient's cognitive and behavioural patterns. As such, an optimal course of therapy would target times when a patient is in a high agency phase with respect to their symptoms, and then channel that agency into other aspects of life.

Although our results provide evidence for an overall reduced sense of agency in individuals who exhibit disordered eating behaviours and cognitions, we did not provide empirical evidence for the volatility of the sense of agency across phases. Future research is needed to gain a better understanding of the sense of agency in individuals with eating disorders. Groups working with AN and BN patients should investigate intentional binding with respect to binging, purging, restricting, and feeding. They should also examine whether self-reported accounts of agencies across these phases are congruent with results from intentional binding. The results of such work can have measurable impact on the patient treatment outcomes and provide valuable insight on the mechanisms that generate the sense of agency in each phase.

CHAPTER FIVE: General Discussion and Concluding Remarks

Over-Arching Goal

The goal of this thesis was to investigate how the sense of agency is affected by social exclusion. In experiments one and two, we used two priming methods to induce feelings of social exclusion in participants. Interval estimates obtained from the intentional binding paradigm were used to index the pre-reflective sense of agency. In experiment three, we explored the sense of agency with respect to a psychiatric disorder associated with chronic social exclusion.

Social exclusion is a profound phenomenon studied across various disciplines. It transpires in various forms including ostracism, bullying, romantic rejection, being ignored, and being discriminated against. In psychology, there currently exists one model for explaining the psychological effects of social exclusion. In this model, social exclusion is thought to threaten our fundamental psychological needs for sense of belonging, sense of control, self-esteem, and sense of meaningful existence. Individuals respond to exclusion episodes based on the perceived relative threat posed to these needs in a given scenario. When the sense of control is perceived as most threatened, the typical response is aggression and a desire to punish. Some of the most harrowing global events, such as school shootings, can be, in part, attributed to the experience of social exclusion. Considering the pressing consequences of social exclusion, now more than ever, research is needed in this area. As such, we have begun to concretize one of the effects of social exclusion, loss of

sense of control, using the sense of agency. Exploring the sense of agency in relation to social exclusion has vast potential to elucidate the underlying mechanisms causing these adverse effects of exclusion.

Two Core Ideas

Idea 1: Social exclusion reduces the sense of agency.

In experiment one of this thesis, we explored the effect of social exclusion on the sense of agency, the feeling of control over our actions and the outcomes of those actions. The pre-reflective, everyday experience of the sense of agency was indexed using intentional binding, a perceived temporal compression between a voluntary action and the action-outcome. An interval estimation task was used to quantify intentional binding. We used a within-subjects design, with three levels of the condition factor: baseline, social exclusion and social inclusion. Participants were primed by recalling personal memories of social exclusion and social inclusion. Results revealed that mean interval estimations were significantly longer after recalling a social exclusion episode compared to after recalling a social inclusion episode and baseline (in which no priming was done). In other words, the intentional binding effect was significantly reduced after social exclusion compared to social inclusion and baseline, indicating a reduced sense of pre-reflective agency following social exclusion.

In experiment two of this thesis, we attempted to triangulate our findings from experiment one, using a different social exclusion manipulation. We used the Cyberball

paradigm, in which participants were made to feel socially excluded in one condition and socially included in another, via a computer ball-toss game. A within-subjects design was used with three levels of the condition factor: baseline, social exclusion, and social inclusion. Intentional binding was indexed using the interval estimation task. As predicted, results revealed that mean interval estimates were significantly longer after social exclusion, compared to after social inclusion and baseline. Interestingly, a secondary analysis revealed an effect of order, in which participants who were included prior to being excluded showed a greater reduction in the sense of agency, compared to those who were excluded prior to being included. We suspect that, in the former case, exclusion elicits a greater violation to the participants' expectations of inclusion, leading to a greater effect of the exclusion prime. Further research employing ERPs could elucidate the neural underpinnings of the observed effect of order.

Prior to our work, the only empirical evidence supporting the claim that social exclusion threatens our fundamental need for the sense of control came from studies using self-report measures of control. Experiment one in this thesis is thus the first paper, to our knowledge, providing evidence for observable effects of social exclusion on the sense of control, via the sense of agency. We were then able to triangulate this finding in experiment two, using a different approach to induce social exclusion. Thus, we triangulated across multiple approaches and came to the same conclusions. These findings have strong implications for future work in this area. A loss in sense of control is associated with various distressing consequences, including antisocial behaviour and psychiatric disorders. With a better sense of how social exclusion affects the experience of voluntary actions, we can

design more productive and pro-social workplace environments. For instance, future research can consider interventions within school systems to restore the sense of agency in youth experiencing bullying. Additionally, given that our legal system is highly reliant on witness testimonies and unanimous jury decisions, we can start to think about how exclusion or isolation in these settings might influence the manner in which one chooses to act.

Idea 2: The sense of agency is reduced in individuals experiencing disordered eating.

Eating disorders are on the rise among young women and men. It is estimated that 30% of girls aged 10–14 report having engaged in some form of disordered eating (McVey, Tweed, and Blackmore, 2004). These statistics are alarming. Yet, little is known about the causal factors of eating disorders. One contributing factor to eating disorders is a loss of the sense of control. This loss of control can be the result of many factors, one of them being hypersensitivity to social exclusion. Recent research suggests that eating disorders provide helpless individuals with a sense of control in their lives. As such, more research is needed to understand the link between eating disorders and the sense of control.

In the current study, we investigated the influence of eating disorder symptomatology on the sense of agency. In particular, we indexed the pre-reflective sense of agency using intentional binding. Based on their responses to a set of 6 questions, participants were grouped according to their most recent eating-related behaviour. Each participant fell into one of the following groups: Purged, Binged, Restraint, or Fed. We predicted that the pre-reflective sense of agency would vary with eating-related behaviours.

Specifically, we proposed that the subset of individuals in the 'binge' group would show significantly longer time interval estimates, indicating a lower sense of agency, compared to the purged, restraint and fed group. Participants in the 'restraint' group were expected to show strong intentional binding and sense of agency. Participants in the 'purge' and 'fed' phases were expected to show intermediate levels of intentional binding. We also predicted that intentional binding would increase with decreasing levels of eating disorder symptomatology (as indexed by a series of questionnaires) across participants. Results revealed no main effect of group on interval estimations. As predicted, we found that higher levels of disordered eating in a subclinical population is associated with longer time interval estimates in the intentional binding task. We conclude that eating disorder symptomatology is, in general, associated with a reduced sense of agency, relative to healthy controls. However, more research is needed to better elucidate the fluctuations of the sense of agency that occur within the various phases of an eating disorder. We suggest that the intentional binding paradigm may provide a promising avenue for exploring these fluctuations across phases.

Challenges in Intentional Binding Studies

Intentional binding studies are not without their limitations. First, it is difficult to standardize what two events participants are providing estimates for, between subjects, and within subjects. For instance, while one participant is providing estimates from the point at which they release the key to the point at which they no longer hear the tone (i.e. the offset

of the tone), another participant may be providing estimates for the point at which their finger makes contact with the key to the onset of the tone. In a within-subjects design, this difference between participants is less important; instead, a limitation occurs when a single participant uses different event markers between blocks. However, experimenters take measures to avoid this issue by instructing all participants to mark the 'action' event as a full depression of the key and the 'effect' event as the onset of the tone.

Priming techniques come with their limitations as well. In using the episodic memory recall task, some participants did not listen to instructions and ended up writing on the wrong topic or wrote too little about the topic at hand. To get around this, experimenters made sure to inform participants to read the instructions of the prime carefully before beginning to write. Experimenters also encouraged participants to use the entire time allotted to them for writing. Additionally, participants were told to turn their phones off and put them away to avoid any distractions during the priming tasks. Moreover, during debrief after the Cyberball game, some participants proved to not be deceived by the manipulation. We had to replace the participants in this case. Another challenge occurred when participants would express their distress about being excluded, during the experiment, and looked to the experimenter for answers. At this point, the experimenter tried to quickly avert the participant's attention to the next task at hand.

Concluding Remarks

The sense of agency is fundamental to everything that we do. As demonstrated in this thesis, social exclusion has profound effects on the sense of agency. Future research directions, apart from elucidating underlying neural and cognitive mechanisms, should include investigating modulators of the effect of social exclusion on the sense of agency. Until recently, it was thought that social exclusion invariably elicits intense social pain. However, I wonder whether the adverse effects of social exclusion, particularly in relation to the sense of agency, vary across culture and time. For instance, in the modern West, where goals and achievements are celebrated, and individual accomplishments are prized, the sense of agency is integral to self-representations. Given our seemingly increased self-focus and exposure to numerous social networking platforms, a question that naturally arises is whether our society has shaped us to be hyper-sensitive to social exclusion. If so, how does this then influence the choices we make in our daily lives? Additionally, in collectivist cultures of the East, is the sense of agency highly related to familial affiliations? For instance, is the sense of agency more adversely affected when a loved one is excluded? In the future, I would like to continue to explore questions related to the effects of social exclusion and the sense of agency.

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APPENDIX: Experiment 3 Prime

In the last 24 hours…

1. Did you binge eat (felt that you consumed large quantities of food in a short period of time)?

2. Did you exercise? If yes, what was the duration and intensity of your workout?

3. Did you eat anything? If yes, describe what you ate. If no, please indicate the last time you ate.

4. Did you engage in purging (i.e., self-induced vomiting, using laxatives)? If yes, please describe the method you used.

5. If you answered yes to more than one question, please list the events in chronological order.

6. Write a brief paragraph describing the details of your experience with the most recent item on your list from question 5 or if you said yes to just one, please address that item in your paragraph.

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