The Psychology of Ritual: An Empirical Investigation of Ritual's Regulatory Functions and Psychological Processes

by

Nicholas Murray Hobson

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Department of Psychology
University of Toronto

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Psychology Department
University of Toronto

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Abstract

Traditionally, ritual has been studied from broad sociocultural perspectives. Recently, however, psychologists have begun turning their attention to the study of ritual, uncovering the causal properties driving this puzzling yet universal aspect of human behavior. With growing interest in the psychology of ritual, the aim of this dissertation was twofold: First, I propose an integrative theoretical framework of ritual that organIntroizes recent empirical work from psychology and the cognitive and neuroscience fields. In this framework I propose that all ritual serves three regulatory functions. Namely, rituals regulate (1) social behaviors, (2) goal states, and (3) emotions. I explain each function by drawing on bottom-up and top-down processes, and suggest that all forms of ritual are a result of some combination of these two levels of psychological processing. Second, I use the framework to generate testable predictions and outline seven experiments as part of this research program. In Studies 1 and 2, I found evidence that novel rituals strengthen ingroup ties but at the expense of outgroup distrust (Study 1), a bias response that is amplified as a ritual becomes more effortful (Study 2). In Study 3, I found that minor variations in the amount of (mis)matching in a ritual sequence predicts differences in group functioning. In Studies 4 and 5, I found evidence to suggest that how a ritual is created, in terms of its physical features, depends on the underlying motivational context (Study 4). As a built-in regulatory mechanism, the embodiment of ritual allows a group to anticipate future goal states, with physical styles of ritual either helping or hindering collective performance (Study 5). The last two studies examined the role that personal ritual plays in mitigating anxiety. In Study 6, I found that ritual is capable of muting the neuroaffective response to failure. Finally, the findings from Study 7 suggest that ritualized movements minimize anxiety by blocking out surrounding

emotional stimuli. The current research contributes to the growing interest in the psychology of ritual. Together, by appreciating the value of psychological theory and experimental methods, the current dissertation broadens our understanding of ritual and human behavior more generally.

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General Introduction and Integrative Framework

1 Introduction

Rituals pervade human life. Whether through religion, business, politics, education, athletics, or the military, rituals are central to the most meaningful traditions and cultural practices around the world. In rituals, the most ordinary of actions and gestures become transformed into symbolic expressions, their meaning reinforced each time they are performed (van Gennep, 1909). The repeated kneeling and bowing of religious prayers signals a commitment to God and provides solace; a team's pregame ritual of putting equipment on from left-to-right (and not right-to-left) empowers athletes to perform at their best; and marriage rituals during the wedding ceremony seal the bond of commitment between two people. Rituals are a fundamental part of human experience, and are therefore of interest to researchers across multiple disciplines interested in human behavior.

The study of ritual has a rich past in the social sciences, mostly among cultural anthropologists and sociologists (e.g., Durkheim, 1915; Geertz, 1973; Levi-Strauss, 1955). Over the past century, the study of ritual has benefited primarily from broad cultural analyses and ethnographic research (e.g., Collins, 2004; Gerholm, 2010; Kapferer, 2004; Lewis, 1980). During this time, however, the micro-level perspective took a backseat to the broader social-level accounts. As a result, there is much less known about the psychological and neural bases of ritual, which operate at the level of the individual.

For my dissertation, I ask the following: *How* are rituals represented psychologically? What mental processes underlie ritual's functions? In my work I take the position that the elaborate rituals observed in the real world, those which have been central to shaping human experience, build on basic neuro-cognitive, affective, and motivational processes. This is the starting point of my research program. In short, the aim of my dissertation is to bring psychology to the study of ritual and to uncover the value of empirical and experimental approaches. I first propose to do this by outlining a broader theoretical framework that focuses directly on the psychological causes and effects of ritual. I apply my framework in order to: (a) develop a comprehensive definition of ritual, (b) organize a set of regulatory functions served by ritual, and (c) explain the underlying psychological processes involved.

2 The Defining Features of Ritual

The question of what constitutes ritual has been a recurring theme in the social sciences and cultural research (Bell, 1997; Boyer & Liénard, 2006; Humphrey & Laidlaw, 1994). Researchers have defined ritual differently when thinking about its various consequences (e.g., Bell, 1992; Bell, 1997; Collins, 2009; Turner, 1969), resulting in a series of incompatible theoretical approaches to the study of ritual (Beattie, 1966). For the purposes of the current paper and framework, a clear and unambiguous definition is needed. Here I emphasize ritual's low-level and high-level psychological and behavioral features.

First, rituals are characterized by a specific set of low-level psychomotor features. For example, rituals involve behaviors that are rigid, repetitive, and attention-grabbing (Foster & Weigand, & Baines, 2006; Rossano, 2012; Tambiah, 1979). Unlike other behaviors, rituals are typically chunked into units of segmented action, which then become sequenced, patterned, and highly repetitive (Nielbo & Sørensen, 2011, 2015). In addition, ritual sequences tend to be done in a fixed and bounded way with little room for change or novelty (Boyer & Liénard, 2006; Liénard & Boyer, 2006). Thus, in contrast to a habit or routine, rituals tend to be invariable over time (Rappaport, 1999; Smith & Stewart, 2011). Because rituals are invariable, they are sometimes characterized as requiring a "scrupulous adherence" to rules, whereby sticking exactly to the script is imperative (Dulaney & Fiske, 1994, p. 245).

Second, the invariability of ritual is also linked to certain higher-order elements that come with performing the ritual, typically enhancing its personal meaning. Consider, for instance, the animal slaughter rituals common to the Islamic and Judaic traditions: When even the smallest detail of the ritual is missing or out of place, such as a quick blade movement in the wrong direction, the entire ritual fails and the meat becomes forbidden to eat (for an anthropological account of ritualistic food restrictions, see Douglas, 1966). In this case, the rules of the ritual simply cannot be relaxed in any way because the ritual themselves – and what they stands for – have significant meaning for the people engaging in them.

Rituals are meaningful and acted out through overt symbolic expression (Radcliffe-Brown, 1939; Turner, 1967). Unsurprisingly then, they are often associated with the idea of self-transcendence and sanctity, with strong links to religion, spiritualism, ancient traditions, mystery, and practices of the preternatural (Bell, 1997; Geertz, 1973; Turner, 1967). Consider, for example, that a habit and ritual action might appear, at first glance, identical in structure, but the

ritual is different (and thus considered to be ritual) because it is imbued with a sense of meaning and because it is symbolically acted out, whereas the habit is not. Indeed, some of our most important rituals would simply appear arbitrary and trivial if the symbolism and meaning were removed. The 21-gun salute during a military funeral service, rather than bestowing the highest honor to a fallen comrade, would be nothing more than group of soldiers firing into the air. Importantly, the act of engaging in ritual (often repeatedly) "ritualizes" the behavior even more, which serves to further distinguish the ritual from other ways of acting in the world. This self-reinforcing process imparts a dominance status onto ritual actions, making them altogether different from ordinary behaviors, and thus more special and more meaningful (Bell, 1991).

The final element of ritual acts as the connecting piece between the low-level and high-level features. By having (i) segmented, rigid actions (low-level) and (ii) symbolic value (high-level), rituals also tend to be goal-demoted (Boyer & Liénard, 2006). That is, rituals either lack overt instrumental purpose, or their constitutive actions themselves are not immediately causally linked to the stated goal of the ritual (Legare & Souza, 2012; Rappaport, 1999). In this sense, rituals are a paradox, being ubiquitous and universal, yet without overt instrumental value and posing real economic and fitness costs (Irons, 2001). Unlike most goal-directed behaviors, which have a clear causal connection between action and desired outcome, rituals are causally opaque (Kapitány & Nielsen, 2015, 2016; Legare & Souza, 2012, 2014) and thus, made up of emotion-laden features that are impervious to rational hypothesis-testing (Rutherford, 2006; Smith & Stewart, 201; Sosis & Ruffle, 2004). Rituals, as a result, often display physical features that appear redundant and arbitrary, characterized by unnecessary amounts of repetitive and stereotypical movements.

We can see that the complex narratives and appraisals that accompany ritual are equally important as their low-level psychomotor features, with the power of ritual coming from these combined psychological experiences. In ritual, abstract symbolic thought is fused with concrete action, a deeply meaningful moment in time when "the world as lived and the world as imagined turn out to the same world" (Geertz, 1973, p. 112). I propose, as others before, that it is this combination of features that makes rituals unique and distinct from other behaviors (Bell, 1992). Together then, combining these separate features, I define ritual as (a) predefined sequences characterized by rigidity, formality, and repetition that are (b) embedded in a larger system of symbolism and meaning, but (c) lack direct instrumental purpose.

3 Ritual's Regulatory Functions

Broadly, I suggest that ritual serves three regulatory psychosocial functions: social, goal, and emotional. That is, most of rituals' functions can be thought of as regulating (1) social behaviors (2) goal-directed states; and (3) emotions.[i] By taking a psychological perspective, the current framework integrates former theoretical (sociocultural) accounts with recent empirical research to show how ritual operates at the level of the individual. From this perspective, ritual is responsible for regulating various emotive, cognitive, and behavioral states.

Such a psychological framework may be new, but the idea of ritual as a regulatory process is not. I seek to leverage this past theoretical work, and build from it. As captured by the paper's opening epigraph, the same set of core functions that represented the dominant line of anthropological thought throughout the 20th century, align closely with our proposed set of functions (Bell, 1991; Homans, 1941; Rappaport, 1967) – rituals are responsible for dispelling anxiety (i.e., regulating emotion), increasing confidence (i.e., regulating goal-cognition), and disciplining organizations (i.e., regulating social behaviors).

Rappaport formally pieced together the notion of ritual as a type of regulatory process, recognizing that rituals are enacted at times as a way to monitor and maintain various psychological and sociocultural states (1967, 1971). He saw rituals as a type of cybernetic or monitoring control system – not unlike the feedback system of a thermostat – for individual and group behaviors. This thinking closely aligns with the cybernetic control models in psychology and neuroscience (Carver & Scheier, 1982; Friston, 2002; Gray & McNaughton, 2000; Powers, 1971). This framework, and the experiments included in my dissertation research, extend the longstanding notion that ritual is a type of regulatory process. Critically, linking past theory with recent empirical science, my aim in the current work is to pay particular attention to the different levels of psychological processing underlying ritual's functions.

4 An Organizing Framework for Ritual

As discussed in the definition section above, ritual is a combination of both high-level inputs (experientially-mediated symbolism) and low-level inputs (segmented, highly sequenced action units), which together, differentiate ritual from other actions (Rook, 1985). Central to my framework, I propose that as the actions begin to unfold (either enacted personally or observed in others), the ritual goes through multiple iterations of processing at these two psychological

levels. The first relates to the *bottom-up* sensorimotor processing generated from ritual's segmented and sequenced actions; the second relates to the *top-down* conceptual processing generated from ritual's enriched meaning and symbolism. In other words, I suggest that the defining features of ritual – the low-level and high-level ones – are favored for either bottom-up or top-down processing, respectively.

Bringing it all together, I organize the working framework as follows: A combination of the three definitional features generates a ritual experience (distinguishable from non-ritual); this leads to the combined processing of ritual's low-level (sequenced, segmented actions) and high-level (symbolic meaning) features; the enactment of the ritual is done to regulate one or more psychosocial states; finally, the function served by the ritual, as well as the processing involved, results in any number of various downstream consequences, including both individual- and social-based outcomes. See Figure 1 for a conceptual diagram of the process. Below I elaborate on the psychological processing that is involved in ritual, and then briefly overview how the current research ties into the overall framework.

5 Ritual's Bottom-Up and Top-Down Processes

Seeing ritual as belonging to these two systems of psychological processing has a metaphorical appeal that has proved useful in past psychological research. First used to explain perceptual and visual processing (e.g., Reicher, 1969; Navon, 1977), the bottom-up and top-down distinction has also been used to understand complex psychological processes, including things like emotion generation (Ochsner et al., 2009), mindful emotion regulation (Chiesa, Serretti, & Jakobsen, 2013), and attentional control (Awh, Belopolsky, & Theeuwes, 2012). Bottom-up perception refers to the processing of stimulus features as they come in, combining the individual parts to create a whole (data-driven). Top-down processing, on the other hand, refers to information-processing that is first driven by cognition and goal priors, where a stimulus is first framed by various expectations and interpretations (rule-driven).

I seek to utilize this same conceptual distinction in information processing to explain the psychology of ritual. I suggest that the integration of these two levels of information processing can explain the varied psychosocial consequences of ritual. Borrowing from work in psychology and neuroscience (e.g., Sarter, Givens, & Bruno, 2000), I propose that ritual is the convergence of the two levels of mental processing – 'where top-down meets bottom-up.'

Bottom-up processing during ritual includes the recruitment of perceptual, attentional, and memory stimulus features tied to the ritual or the surrounding environment. These processes derive from the low-level, sensorimotor elements of ritual – the experience or enactment of particular physical actions that compose a ritual. Because they are comprised of highly stereotyped and rigid action sequences, rituals tend to be parsed into segmented action units. This form of event segmentation, akin to object segmentation, is a naturally occurring cognitive process that economizes perception and guides attention and memory (Newtson, 1976; Zacks & Swallow, 2007; Zacks, Tversky, & Iyer, 2001). I suggest that the sensory experience of engaging in repetitive and sequenced actions, as well as the motor control required to enact these actions with care, leads to a regular stream of event segmentation, which makes ritual more attention-grabbing and more memorable than non-ritualized actions (Boyer & Liénard, 2006; Nielbo & Sørensen, 2011).

Top-down processing, on the other hand, is associated with the integration of these physical motoric features into broader narratives, appraisals, and interpretations. This high-level, context-dependent processing that is done during (and many times after) ritual performance involves the elaboration of stimulus properties into meaning appraisals, which often reaffirms the purpose of completing the ritual in the first place. Ritualistic sequences, by virtue of being perceived as ritual and not some other patterned behavior, are more than the arbitrary physical movements that comprise them. Instead, the actions are interpreted as a practice that is meaningful, providing context and connecting a person to something that is bigger than themselves – an ancestry, familial traditions, cultural and religious groups, nature, immortality, and the like. The separation of ritual from other ordinary, more mundane behaviors affords it a special status (Bell, 1997; Berggren & Stutz, 2010). This special quality of ritual means the actions involved, as well as the context in which they are done, are inherently more valuable than other actions. This heightened value or meaning communicates a clear signal to oneself (self-signaling) or other people (social signaling) that something of significance has been done, which carries larger consequences for a person or group.

We can look to the behavior of ritualistic prayer as an example of this bottom-up/top-down combination. A person who prostrates during the Islamic Salat at precisely timed moments is engaging in low-level, fixed physical actions. The stereotyped, repeated movements segment the prayer event and automatically grab the person's attention, focusing their experience on the

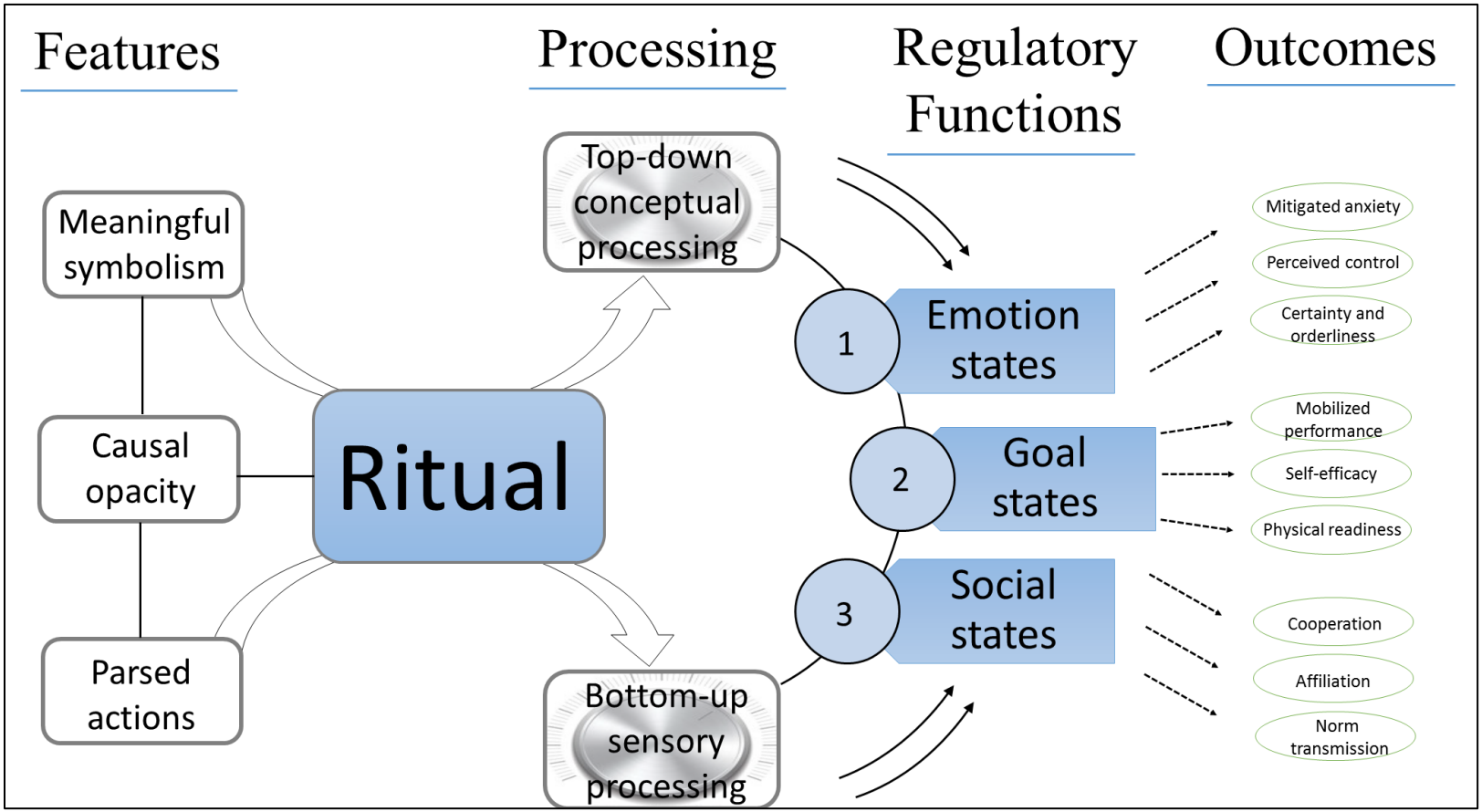
careful completion of the correct sequences (i.e., bottom-up sensorimotor processing of controlled parsed actions leading to biased attention). And yet, at the same time, doing the ritual correctly signals to the person, and perhaps to others, that they are a devoted Muslim who prays the right way according to the Quranic scripture. Similarly, when done properly, the movements that comprise the prayer become much more than mere physical movements; they are imbued with sanctity and meaning, *each time* they are performed (i.e., top-down conceptual processing of symbolic value leading to broad implications). In the experiments that follow I show how such cases of ritual – religious and secular – can be dissected into their constituent processes.

I intend to show that all forms of ritual, no matter how different they appear on the surface, are a result of some combination of these bottom-up and top-down psychological processes. Thus, rather than seeing the various expressions of ritual as distinct cultural phenomena merely called by the same name, the framework and associated research will allow researchers to think about a common underlying psychological basis that unites *all* types of ritual. Recent computational modeling offers insight into how the bottom-up and top-down processes combine during ritual. Using data simulation techniques, the basic action units of ritual i) allow for greater allocation of attentional resources (i.e., bottom-up) and ii) can be modulated by culturally-mediated meaningful experiences (i.e., top-down), what the researchers call "cultural priors" (Nielbo & Sørensen, 2015). This enhanced integration distinguishes meaningful cultural rituals from, say, the chaotic and incoherent ritualized behaviors typical of pathology. In line with this work, my position is that each ritual will have varying degrees of bottom-up and top-down processing, rather than the same amount in every context. These relative weightings, which are determined by the specific purpose served by the ritual, will alter the psychological experience for the person, and ultimately lead to different outcomes in the ritual experience.

Altogether, as part of my dissertation, I seek to offer a working framework that is comprehensive and integrates all aspects of ritual's psychology. Using Figure 1 as the framework's roadmap, a researcher can target these different aspects when formulating a set of questions: One might focus on ritual's defining features and their independent (and overlapping) causal influence, or on how a regulatory function leads to a certain psychological outcome, or more still, on how the combined systems of psychological processing underpin these various functions and outcomes. Whereas before it was necessary to study ritual as a whole, here it is broken down into its constituent parts. The type of approach I take here – sometimes referred to

as ritual "fractionation" – suggests that studying the imprecise category of "ritual" needs to be done by fractionating its individual components, thus allowing researchers to derive specific predictions related to each component's separate causes and effects (Whitehouse & Lanman, 2014). As an empirical science, experimental psychology is well-suited for the job.

Figure 1. Visualization of the proposed theoretical framework. Ritual consists of three defining features: parsed actions, meaningful symbolism, and causal opacity. These high-level and low-level features undergo top-down conceptual processing and bottom-up sensory processing, respectively. The combined processing underpin the three main regulatory functions served by ritual, each of which produce various observable behavioral and psychological outcomes.



6 Summary and Research Outline

The value of the proposed framework lies in its ability to generate testable predictions. With emphasis on ritual's individual components and underlying psychological processing, the current research provides a set of falsifiable hypotheses. Across seven experiments, I test a series of predictions broadly covering the three different regulatory functions (i.e., social, goals, and emotions). Consistent with real-life examples, the present studies account for the fact that rituals can be performed either by a single person or multiple people. The first five experiments focus on collective rituals, which are more aligned with the social function; the last two experiments focus on individual rituals, which here are more aligned with the goal and emotion functions.

That said, I caution the reader to think of rituals as cutting across these three categories, with collective and personal practices existing along a dimension. Though treated as separate for conceptual purposes, most rituals do not serve a single function exclusively. For example, when a religious group engages in a ritualistic prayer during a holiday celebration, they strengthen group ties (i.e., the ritual's social function) but also regulate a sense of collective joy (i.e., the ritual's emotion function).

The research that follows begins with the commonly held view that rituals regulate social behaviors by heightening group affiliation and coordinating group members. In Studies 1 and 2, I challenge the basic assumption that ritual's social function is exclusive to prosocial motives. In other words, I wonder if rituals are also responsible for regulating a person's behavior towards someone with whom they *do not* share a ritual experience, namely an outgroup member. Specifically, I examined the effects of ritual in an intergroup context to see whether ritual's prosocial effects are limited to ingroup interactions. Continuing on with ritual's social function, in Study 3 I tested a mechanism believed to be responsible for ritual's impact on group affiliation: physical synchrony. I examined if the amount of group cohesion experienced during (and after) a collective ritual is directly linked to the amount of matching in ritual sequences. Additionally, I investigated how these bottom-up sensorimotor processes of synchronous (mis)matching combine with the top-down appraisals related to the group experience. I expected to find that doing a ritual that matches (versus not) would enhance the meaning of the experience, and in turn, promote group cohesion (versus group dissolution).

Studies 4 and 5 looked at the embodiment of various ritual states. At the heart of ritual lies outward physical movement – the expression of abstract beliefs through concrete action (Geertz, 1973). To what extent does this concrete action matter for group functioning? In these studies, I combine two of the three regulatory functions proposed in the framework, demonstrating how certain collective rituals are capable of binding group members (social regulation) and also mobilizing goal performance (goal regulation). Study 3 examined the question of why rituals look different, physically speaking, and how this ties into group functioning and goal performance. Specifically, I sought to show how a ritual is constructed (its physical features) depends on the motivational and goal context. Extending this, Study 4 manipulated the physical style of ritual in order to further verify the prediction that not all ritual actions are the same; to see if certain ritual movements are better suited to facilitate effective joint performance depending on the goal context.

For the last two studies, I focused on individual rituals. Like collective rituals, these individual rituals are ubiquitous and expressed in different domains. They are often done in situations requiring enhanced performance, particularly when the pressure to perform well is met with the anxiety of experiencing potential failure. Relatedly, an individual ritual can act as a palliative in situations of uncertainty, creating a sense of compensatory psychological order. Studies 6 and 7 examined the underlying basis of such ritual behaviors, focusing on both the goal regulatory and emotion regulatory function of ritual. In these investigations, we see once again how ritual's functions overlap with one another. For Study 6 I investigated ritual's neural underpinnings, delving deeper into the question of how exactly ritual regulates performance failure and anxiety at the level of the brain. Finally, in Study 7 I asked if basic repetition is a key feature of ritual movement in helping reduce anxiety. Here I tested the prediction that ritual's bottom-up processing of rigid, repetitive actions assists in blocking emotional stimuli that would otherwise cause anxiety.

As a final comment before continuing, I note that in all the studies that follow, the operationalization of ritual is an integral part of my research. To be able to say with certainty that ritual – or a specific component of ritual – leads to a change in whichever psychological or behavioral outcome, the imprecise construct of ritual needs to be isolated and experimentally controlled. Using real-life ritual precludes researchers from drawing the exact causal inferences thought to be involved in ritual. As such, the imprecise understanding of ritual remains. To

circumvent the problem, the rituals (or ritualized actions) used in the current research are entirely novel and arbitrary, and control for different pre-established features. Across studies, the operationalization of ritual varies to include week-long experiences at home, one-off situations in the lab, and basic motoric (ritualized) actions happening outside conscious awareness. Such ad-hoc ritual constructions are central to the proposed psychological framework because they allow researchers to ask (and answer) questions of causality; they allow for a *science* of ritual.

Chapter 2
Ritual and Intergroup Bias

1 Study 1 Introduction

A puzzling feature of rituals is that they have managed to pervade human culture despite the considerable costs incurred from their regular performance. Game-theoretical approaches (e.g., Henrich, 2009) address this puzzle by suggesting that shared rituals help large groups survive by acting as a bulwark against the free-rider problem (Norenzayan et al., 2016). Theories of costly signaling suggest that rituals serve as a credible public signal, advertising people's beliefs and intentions (Atran & Henrich, 2010). Taking the time to master a group's ritual – for example, enduring the attendant physical and psychological pains and committing time and energy – makes being rejected by the affiliated group particularly undesirable (Alcorta & Sosis, 2005). That is, ritual increases group success through honest signaling of loyalty.

Indeed, rituals observed in the field have been linked to increased group cohesion. For instance, males belonging to religious Israeli kibbutzim – marked by increased communal ritual practices and synagogue attendance – show more cooperation towards ingroup members (Sosis & Ruffle, 2003). Field research investigating variations in ritual costliness has shown that more effortful rituals are linked to group cooperation and prosocial behaviors (Xygalatas et al., 2013), with high-intensity rituals resulting in the synchronization of autonomic physiological activity between performers and observers (Konvalinka et al., 2011). Moreover, ethnographic evidence suggests that collective rituals are associated with effective group functioning, linking ritual to a group's ability to withstand social collapse (Sosis & Bressler, 2003; Tuzin, 2001).

However, these benefits do not come without costs: greater affiliation with ingroup members can have negative consequences for outgroup members. Intergroup competition plays a critical role in the cultural evolution of intragroup cooperation (Gurerk, Irlenbusch, & Rockenbach, 2006); game theory suggests that ingroup altruism is a stable strategy only when coupled with outgroup hostility (Choi & Bowles, 2007; Saaksvuori, Mappes, & Puurtinen, 2011). Supporting these theories, ethnographic studies on religion and ritual show that heightened intergroup conflict and outgroup hatred are linked to greater ingroup commitment to sacred values and engagement in more effortful and costly ritual group displays (Ginges, Atran,

Medin, & Shikaki, 2007). For example, the amount of time invested in group ritualistic prayer predicts support for suicide attacks (Ginges, Hansen, & Norenzayan, 2009).

This largely correlational research is consistent with our primary hypothesis: rituals galvanize ingroup solidarity, but with costs to members of outgroups. However, because real-life rituals are imbued with culture, history, and preexisting meaning, parsing the causal impact of rituals is challenging. Without controlling for these broad social and group variables, the causal influence of ritual cannot be isolated. Thus, novel rituals – behaviors created in the lab, devoid of historical meaning and culture – allow us to address the psychology of ritual and its effects on intergroup bias. Although rituals can vary widely in their expression (e.g., Whitehouse, 2002), here I operationalize ritual at its most basic level, defining it as a sequence of repeated or stereotypical actions that have no instrumental causal link to a desired outcome.

Thus, the primary goal of these first two studies was to create both novel groups and novel rituals to assess the causal impact of rituals on intergroup bias. Importantly, the experimental design was intended to maximize the "ritual" aspect of the experience while minimizing the "group interaction" aspect, allowing me to control for any impact of group interaction in order to draw causal inferences about the specific effect of rituals on intergroup bias.

In Study 1, I investigated the effects of novel rituals on intergroup bias by assigning some participants to enact a ritual at home for one week before a laboratory session in which they are assigned to novel groups using a minimal groups paradigm (Tajfel, Billig, Bundy, & Flament, 1971); I used a behavioral measure of economic trust to assess intergroup bias.

1.1 Study 1 Methods

1.1.1 Participants and Power Analysis

One hundred and seven introductory psychology students at the University of Toronto Scarborough participated for course credit; in addition, all participants were informed that they could earn extra bonus money based on their decisions during the experiment; in the end all participants received the same $10 for participating. Participants were randomly assigned to either a ritual condition or a no-ritual control condition. Seven participants from the ritual condition were excluded from analyses because they failed to complete the assigned at-home

portion of the experiment (less than 3 times over the course of the week), which was determined by the number of survey log-ins tracked during the at-home portion and confirmed with participants during the funnel debriefing of the lab portion ($M_{total\ compliance}$ = 4.97). None of the participants expressed suspicion of the role of confederates. The final sample consisted of one hundred participants (25 male, 75 female; M_{age} = 18.8, *SD* = 1.57; ritual condition n = 42, no-ritual condition n = 58).

Sample size was determined (to ensure sufficient power) using an a priori power analysis (*G*Power*; Faul, Erdfelder, Lang, & Buchner, 2007), which assumed a medium effect size (characteristic of most social psychological findings). Specifically, with an assumed effect size of d = 0.4 (Richard, Bond, & Stokes-Zoota, 2001), our mixed design could achieve 80% power with as few as 72 participants, assuming a modest (r = 0.3) correlation between our repeated dependent measure. I decided to collect data until the end of the term, assuming I collected at least 72 participants.

1.1.2 Procedure

The experiment was comprised of an at-home and in-lab portion, lasting one week. At the beginning of the at-home component, participants in both conditions estimated the number of dots in a series of images, as in the classic minimal group paradigm (Tajfel, 1974). Unlike the classic manipulation, which tends to occur at one time in the lab, participants were not told immediately about the arbitrary grouping assignments (i.e., putting people into groups of "under-estimators" and "over-estimators" based on their responses). Participants were led to believe that their estimates were being recorded in a data file, which was then ostensibly used a week later in the lab to determine the minimal groups.

In the ritual condition, participants were given instructions to learn and memorize a set of actions. To motivate completing the actions over the course of the week, participants were led to believe that the actions were thought to be part of an ancient cultural practice and that the purpose of the experiment was to understand the relationship between these action sequences and various cognitive processes. The instructions read as follows:

> *The purpose of this study is to connect people with ancient culture, and to demonstrate the effects of these cultures' various practices. As part of this, you will be asked to learn*

a shortened version of one of these ancient action sequences and to master it over the course of the week. We will send you daily emails, which will help serve as a reminder for you to perform the action sequence.

The two-minute long, ad-hoc ritual was comprised of a series of sequences that included raising the hands above the head and in front of the body, bowing the head, and opening and closing the eyes. My operationalization of ritual was designed to mimic the physical features of real-life ritual behavior, namely, repetitive and highly sequenced movements, clear start and end times, and set rules and guidelines (e.g., "ensure you complete the sequences exactly in this way and not in any other"; Norton & Gino, 2013). Note that there was no mention of "ritual" during the week-long study; the word ritual itself is imbued with preconceived notions of the psychological effects of rituals. Along with the written action sequences, participants were also told to watch a video of a model displaying the full set of actions. Participants were asked to learn and memorize the sequences over the course of the week.

All participants were sent email reminders every day during the at-home portion. Participants in the ritual condition were reminded to perform the actions and were provided with the video as an aid for the first three days (the last three days did not include the video). In order to equate time spent, participants in the no-ritual condition completed filler questions related to cognitive processing for the same amount of time. Compliance of the at-home portion (completing the actions and survey) was tracked using the survey page option, which allowed us to see whether participants had logged in to watch the video and complete the action sequences. The experimenter checked this information for each participant, and low-compliance participants (completing the actions/survey less than 3 times out of 7 days) were removed from the final analysis. Low compliance was also confirmed during the funnel debriefing in which participants were asked to report the number of times they completed the actions over the course of the week.

After one week, participants completed the in-lab portion of the experiment in groups of four: three participants and one confederate. Participants were informed that the experiment was a group experiment; to manipulate the group variable, the experimenter – seemingly using the saved data from participants' dot-counting responses earlier in the week – informed participants (and confederates) that their data showed them to be under-estimators, assigning them to the red

group. The assignments were revealed at this point to minimize the amount of group experience. Participants were told that the outgroup – whose data showed them to be over-estimators – were assigned to the blue group and were ostensibly completing the same experiment in a neighboring lab space. (In fact, there was no blue group and all participants were assigned to the red group). A headshot of each participant was then taken and they were informed that each person's picture would be uploaded to the main computer to be used later in the experiment; in fact, the only images that were loaded were those of the confederates.

Participants in the ritual condition then performed the action sequences one final time: they lined up beside one another, facing a wall such that they could partially see the others to their left and right performing the actions. Given research on the effects of synchronization and mimicry on prosociality/cooperation (Wiltermuth & Heath, 2009), the timing of the actions was intentionally staggered by ten seconds to prevent participants from coordinating with each other's movements – allowing us to examine the effects of novel ritual controlling for any effect of synchrony. Participants in the no-ritual condition spent the same two minutes completing another round of dot-counting in their group, controlling for group salience and time, and told that this confirmed their previous grouping assignment. By having participants in the control condition complete a survey for the same amount of time, and confirming their group assignments, the assumption was that all participants would have their identity validated equally.

Finally, participants completed a series of rounds with multiple partners of the Trust Game (Berg, Dickhaut, & McCabe, 1995; Sapienza, Toldra-Simats, Zingales, 2013). The Trust Game is an economic game assessing social preferences that has been used extensively to measure trusting and trustworthy behavior between two or more people (e.g., Sapienza, Toldra-Simats, Zingales, 2013). As a result, it is well-suited for testing (economic) trust between members of different groups. In two rounds of the game, participants "interacted" with a member of their ingroup and outgroup separately on a computer. Unknown to participants, the images were of confederates. In each round, participants (always in the role of the sender) were allocated $10 with the option to send any amount (or none) to the receiver. They were instructed that the initial amount sent would be tripled and given to the receiver who then had the option to either keep all of the money or return any amount of it to the sender. The game was explained as follows: If player 1 (sender role) sends player 2 (receiver role) all of their $10 endowment, this

$10 amount becomes tripled upon being received by player 2 ($30). In the second exchange (which did not actually occur, but participants were lead to believe that there was a second play), player 2 is then given the option to reciprocate the offer and send any amount of the $30 back to Player 1. A perfectly cooperative exchange would be player 1 fully trusting player 2 (sending entire $10) to fairly reciprocate the offer (signaling their trustworthiness) by splitting the $30, $15 to each player.

Participants understood that in order to gain more than their original endowment, they would need to trust player 2 with a certain amount; the more money sent to player 2, the higher this individual payout, but the greater the risk of the endowment being lost. To make sure that participants understood the logic of the exchange, they were provided with different combinations of payouts and winning/losing contingencies. They continued with the real interactions only once they understood how everything worked. Importantly, to have participants treat the task as an economic exchange with real consequences, they were told that their individual outcomes from each interaction/round would be added and averaged together, and that they would take this amount home in cash. Because there was no actual player 2 in any of these interactions, the participants across both conditions took home the original $10 regardless of their decisions during the rounds.

1.2 Study 1 Results and Discussion

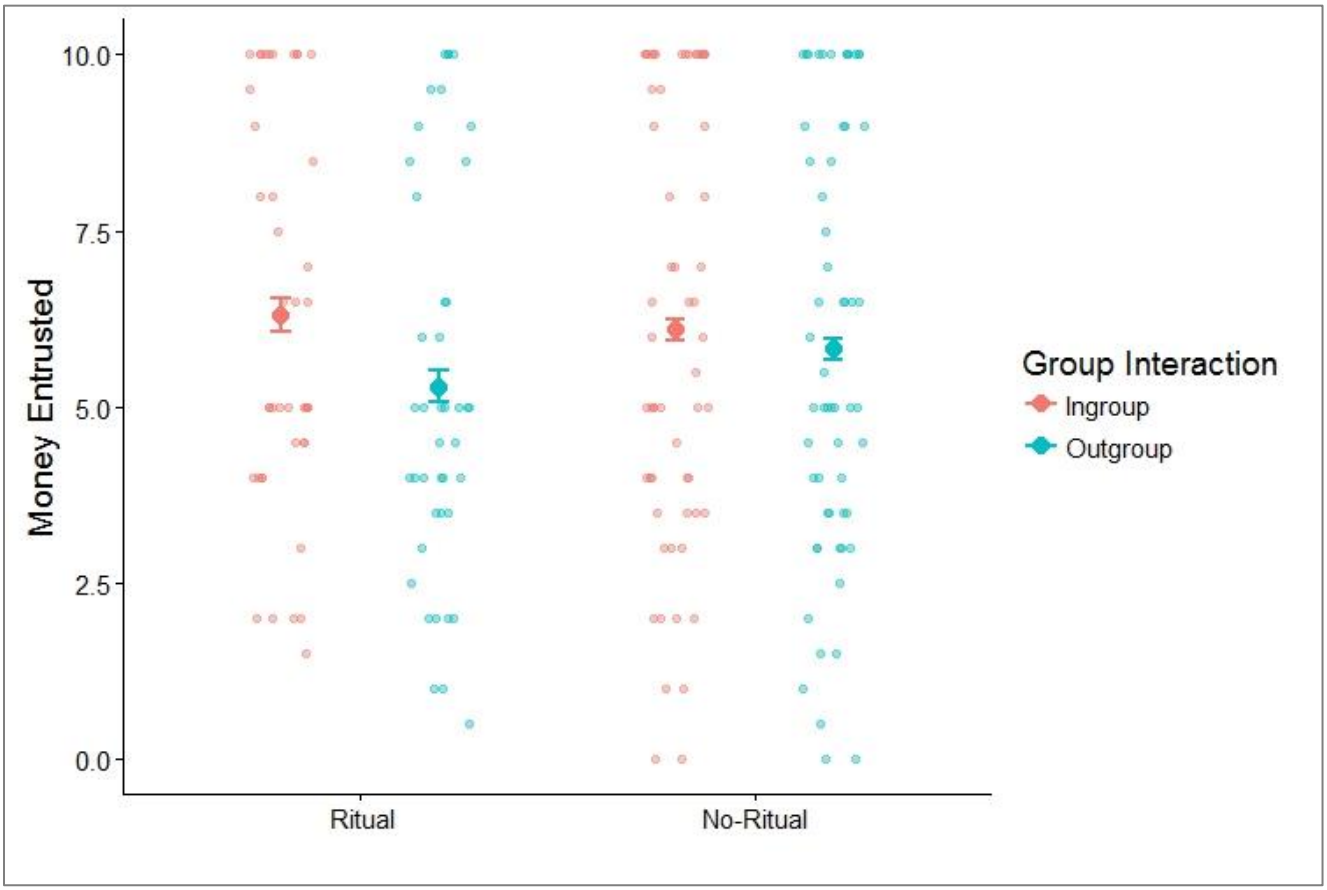
A 2-level multilevel model was used to account for Trust Game trials (i.e., amount sent) nested within participants by estimating a random intercept for each person. I used an unstructured covariance matrix and the between-within method of estimating degrees of freedom. Effect sizes were estimated with *semi-partial* R^2 (Edwards, Muller, Wolfinger, Qaqish, & Schabenberger, 2008).

The model revealed a main effect of group status on the amount of money entrusted (b = -0.32, SE = 0.07, $t(99)$ = -4.86, p < .000004, 95% CI = [-0.46, -0.19], *semi-partial* R^2 = .167) such that participants entrusted more money to ingroup than outgroup members. Most importantly, the interaction between ritual and group status was significant (b = -0.19, SE = 0.07, $t(99)$ = -2.86, p = .005, 95% CI = [-0.32, -0.06], *semi-partial* R^2 = .08). As predicted, participants in the ritual condition entrusted significantly less of their money to outgroup ($M_{outgroup}$ = 5.29, SD = 2.80) than ingroup members ($M_{ingroup}$ = 6.30, SD = 2.80), $t(99)$ = -5.05, p

= .000002 whereas participants in the no-ritual condition entrusted comparable amounts ($M_{outgroup}$ = 5.82, SD = 3.08; $M_{ingroup}$ = 6.10, SD = 3.14), $t(99) = -1.55$, $p = .12$. See Figure 2 for the graph displaying the differences in means between conditions. Examining the between-factor simple effects and comparing across condition, I found no statistical differences either for the ingroup comparisons or the outgroup comparisons (all ps > .25). As a result, comparing across conditions it is not possible to infer whether the bias caused by the ritual was driven more by ingroup trust or outgroup distrust.

This first study demonstrates a link between ritual and intergroup bias. Performing novel, arbitrary action sequences and learning that this experience was either shared by others (ingroup members) or not (outgroup members), was enough to lead to biases in economic giving behavior.

Figure 2. Evidence that a minimal ritual leads to increased biases in trust behaviors. Least-squares predicted means display the amount of money entrusted as a function of ritual (ritual versus no-ritual control) and group (ingroup or outgroup member; Experiment 1). 95% confidence interval error bars.



2 Study 2 Introduction

The observed biases in Study 1 may be a consequence of the level of involvement associated with the ritual-like actions. Costly signaling theory suggests that the persistence of extravagant, onerous ritual is linked to the stability of cooperation within (Xygalatas et al., 2013) and conflict between (Sosis, Kress, & Boster, 2005) groups. Bringing this concept into the laboratory for a causal exploration, in a second experiment I test the idea that variations in ritual effort or elaboration (i.e., actions that are "costly") will modulate intergroup bias. I used the same novel ritual paradigm – but varied the extent to which the ritual was simple or elaborate – to explore a moderating role for effort in the effect of rituals on intergroup bias.

2.1 Study 2 Methods

2.1.1 Participants and power analysis

One hundred students at the University of Toronto Scarborough participated for course credit with the possibility to earn additional money (as in Experiment 1). Ten participants from the two ritual conditions were excluded from analyses because they failed to complete the assigned at-home portion of the experiment (less than 3 times over the course of the week; $M_{total\ compliance} = 4.73$). None of the participants expressed suspicion of the role of confederates. Participants were randomly assigned to one of three conditions: an elaborate-ritual condition ($n = 29$), a simple-ritual condition ($n = 30$), and a control no-ritual condition ($n = 31$). The final sample consisted of ninety participants (27 male, 59 female, 4 unreported; $M_{age} = 20.3$, $SD = 2.83$).

The final sample size was determined using an a priori power analysis with *G*Power* software (Faul et al., 2007). Specifically, I partially based our power analysis on the results from Study 1, where the correlation between our repeated measures was $r = 0.89$ and the effect size was semi-partial $R^2 = .08$. To be conservative, I used a smaller effect size of $d = 0.3$ (smaller than the average effect in social psychology) and a correlation of $r = 0.8$ for the repeated dependent variables. With these as inputs into G*Power with a mixed design with three groups, I could achieve 80% power in detecting the omnibus interaction effect with 48 participants. I decided to collect data until the end of the term, assuming I collected at least 48 participants.

2.1.2 Procedure

The procedure and design was similar to that of Experiment 1, with the same week-long at-home portion and minimal group manipulation, with a few key changes. To increase the credibility of the grouping assignments, I included four extra confederates who acted as the minimal outgroup members and who, after being designated the outgroup, were taken to the neighboring room. That is, participants began the experiment in the presence of both ingroup and outgroup members. In addition, I altered the experiment's framing. Whereas in the first experiment the action sequences were framed as having some level of ancient or cultural meaning, in Experiment 2 the framing was as vague and neutral as possible. Participants were informed that the experiment was related to physical movement and its effects on cognitive processing. In other words, I wanted participants to perform the sequences without any preconceived notion of ritual, including any reference to ancient cultural practices. Specifically, they were told:

> *Research has found a link between different types of bodily actions and cognitive functions. The purpose of the current study is to therefore extend these findings to a representative Canadian sample. As part of this, you will be asked to learn a set of short physical sequences and eventually master it over the course of the following week. We will send you daily emails, which will help serve as a reminder for you to perform the action sequence.*

The actions in the elaborate-ritual and simple-ritual conditions were made up of the same ritual-like features as in Experiment 1, but varied in their level of complexity and length. Specifically, the simple-ritual sequence was shorter, less stringent in its rules and guidelines, and involved less repetition; the elaborate-ritual sequence was longer and more involved, stricter in its rules, and also utilized coins and water as ritual instruments.

Using a piloted pretest, the three rituals (intermediate ritual in Study 1; simple and elaborate ritual in Study 2) were independently rated by a separate sample (N=54) on their level of perceived effort and elaborateness using a 0 (no effort, very simple) to 100 (extreme effort, very elaborate) scale. Analyses confirmed that the simple ritual was judged as least effortful and

most simple (M_{effort} = 47.9; $M_{elaborateness}$ = 51.4), the elaborate ritual as most effortful and most elaborate (M_{effort} = 63.7; $M_{elaborateness}$ = 73.5), and the intermediate ritual as falling in between (M_{effort} = 55.2; $M_{elaborateness}$ = 58.8) (effort: F (2,53) = 19.37, p < 0.001, $\acute{\eta}^2_p$ = .27; elaborateness: F (2,53) = 22.32, p < 0.001, $\acute{\eta}^2_p$ = .30). The same at-home portion and in-lab minimal group manipulation was used as in Experiment 1. Participants completed the Trust Game like before, but instead of two interactions, there were four – two ingroup confederate interactions and two outgroup confederate interactions. As in Experiment 1, there was a week-long at-home portion and a final in-lab testing session.

2.2 Study 2 Results

Similar to Study 1, a 2-level multilevel model was used to account for Trust Game trials (i.e., amount sent) nested within participants by estimating a random intercept for each person. The model revealed a significant main effect of group status on money entrusted (b = 0.16, SE = 0.08, t(267) = 2.11, p = .035, 95% CI = [0.01, 0.31], *semi-partial* R^2 = 0.05): participants entrusted more money to ingroup than outgroup members. A model comparison test was done with a chi square test of independence, in which the test statistic degrees of freedom is reported as the difference in the degrees of freedom between the omnibus and interaction-removed models (e.g., West, Aiken, & Krull, 1996). This revealed a small effect, χ^2 (2) = 4.97, p = .08, partially supporting the inclusion of the interaction term as the better fitting model, t.[ii]

Even in the presence of a non-significant omnibus interaction (p = .08), I still had reason to examine the condition pairwise comparisons, given the findings from Experiment 1 and the current predictions regarding trust game allocations for the elaborate versus simple ritual conditions. From this, I found that participants in the elaborate-ritual condition entrusted significantly less money to outgroup members ($M_{outgroup}$ = 5.66, SD = 3.35) than ingroup members ($M_{ingroup}$ = 6.38, SD = 3.09), t(267) = 2.58, p = .01, an effect that was absent in the simple-ritual condition ($M_{outgroup}$ = 5.79, SD = 3.36; $M_{ingroup}$ = 6.10, SD = 3.41), t(267) = 1.52, p = .13, and no-ritual control condition ($M_{outgroup}$ = 6.47, SD = 3.21; $M_{ingroup}$ = 6.40, SD = 3.0), t(267) = 0.50, p = .62. Finally, looking at the between-factor simple effects and comparing across condition, I found no statistical differences either for the ingroup comparisons or outgroup comparisons (all ps > .25). See Figure 3 for the graph displaying the differences in means between conditions.

Figure 3. Evidence that variation in ritual costliness modulate biases in trust behaviors. Least-squares predicted means display the amount of money entrusted as a function of ritual type (elaborate ritual versus simple ritual) and group (ingroup or outgroup member; Experiment 2). 95% confidence interval error bars.

2.3 Study 2 Discussion

These results offer partial evidence that differences in ritual effort – varied at a basic level in my paradigm – produce different levels of intergroup bias. Although I did not find a significant interaction between type of ritual and the amount entrusted in the Trust Game, the simple effects offered modest support for our predictions. Although the amount of relative effort for the elaborate ritual registers a minor cost for the individual, especially compared to the onerous behaviors of real-life rituals, it is sufficient to elicit intergroup bias. Critically, however, I did not observe intergroup bias in the simple ritual condition, suggesting that not all novel rituals elicit intergroup bias. A novel ritual that is too minimal – requiring too little investment and involvement – does not seem to generate bias.

We note that across the two studies we failed to find a basic minimal-group effect in the no-ritual (control) condition, a null finding that is potentially at odds with the established literature on minimal groups. However, whereas minimal-group studies have typically used point-allocation matrices to measure bias (e.g., Tajfel et al., 1971), our studies relied exclusively on the trust game. Furthermore, the initial group assignments were done a week before the laboratory task, whereas the classic minimal group manipulations are done immediately before the collection of the dependent measure.

Together, the findings from Experiments 1 and 2 provide mixed evidence that novel rituals inculcate intergroup bias: Only those with an intermediate or elaborate amount of effort generate bias in trust behavior, which suggests then that there are certain features consistent with real-life ritual practices that need to be present in order to influence group functioning.

Chapter 3
Ritual (Mis)match and Group Functioning

1 Study 3 Introduction

Durkheim (1915) thought that group rituals create group cohesion through "collective effervescence," a state of perceived oneness with the group brought on by synchronized states. Collective rituals typically involve several steps that an individual performs simultaneously with fellow group members, which makes synchrony a potential mechanism by which group rituals increase group cohesion. Looking at the mass coordination of many public religious rituals (often involving thousands of people moving in unison), it is easy to see how the rhythmic and rigid nature of these movements make them conducive to behavioral synchrony and, in turn, increased group cohesion.

Research has shown that synchronizing movements promotes positive feelings towards others. For instance, it has been demonstrated that synchrony – from finger-tapping to full-body marching – increases prosocial tendencies, including affiliation, compassion, and cooperation (Hove & Risen, 2009; Valdesolo & DeSteno, 2011; Wiltermuth & Heath, 2009). Recent research with group ritual specifically has found that group rituals that involve more synchronous body movements are associated with more trust, cooperation, and feelings of oneness than are other group rituals (Fischer et al., 2013).

This begs the question: What happens when group members fail to synchronize during a ritual experience? Rituals contain highly rigid, ordered sequences that follow a prescribed script. This unique structure inherent in ritual makes possible interruptions and mismatches more likely (compared to non-ritual group behaviors), especially in group contexts where such missteps can be easily monitored and detected. As much as a successful (matched) ritual is good for groups, a failed (mismatched) ritual might be less so, and might even lead to worse outcomes than if a ritual was never enacted.

1.1 Hypotheses

Leveraging work in behavioral synchrony, here in Study 3 I examined differences in ritual matching and the influence on group functioning. In a between-subjects manipulation, I randomly assigned participants to either a matching or mismatching ritual condition where they

engaged in an ad-hoc group ritual in preparation for a joint task performance in the lab. Similar to the previous two studies, here I use arbitrary rituals in novel groups to infer causality of the ritual actions themselves (controlling for the pre-established non-ritual features). I predicted that the groups enacting a set of matching ritual actions, compared to mismatching actions, would report higher levels of group affiliation with fellow members, which would be explained by positive attributions related to participants' ritual experience.

2 Study 3 Methods

2.1 Participants and Power Analysis

A power analysis using *G*Power* (Faul et al., 2007) was run to determine adequate sample size. With a between-subjects design, and assuming the typical moderate effect size in social psychology (i.e., $r = .21$, $d = .43$; Richard, Bond, & Stokes-Zoota, 2001), I determined that a total sample size of 180 participants yields a power value of 0.80 for detecting the hypothesized omnibus main effects. I therefore decided to stop data collection around this point.

One-hundred and eighty seven students at the University of Toronto Scarborough participated for course credit and the option to earn more bonus pay (53 male, 127 female, 7 unreported; $M_{age} = 18.42$, $SD = 1.25$). In a between-subjects design, participants were randomly assigned to one of two conditions: a match ritual condition ($n = 93$) and a mismatch ritual condition ($n = 94$).

2.2 Procedure

Participants were told that the purpose of the experiment was to measure the effects of gestures on joint task performance. Participants were told that at the end of the experiment, they would work with their group on coordinated task. In order to incentivize performance and maximize the group aspect of the experiment, the experimenter told participants that the better they did together on the task, the more money they would take home (split evenly among group members).

Before starting the task, however, participants were informed that they would create their own group ritual to prepare themselves for the upcoming performance. In both match ritual and mismatch ritual conditions, the experimenter provided participants with a list of five different

possible ritual features; participants were asked to choose three features in creating their ritual (in any order). The instructions specified that each feature chosen should be repeated three times in the sequence, for a total of fifteen ritual steps. The five possible features to choose from included: chanting (e.g., any phrase shorter than six words); foot/leg movements (e.g., stomping down with the leg); arm/hand movements (e.g., clapping hands); head movements (e.g., bowing); breathing (e.g., sighing).

In the matching ritual condition, participant groups were given five minutes together to create their group's ritual, choosing from the five available features. In the mismatch ritual condition, the experimenter first separated the participants and then asked each person to choose their own three ritual features. To control for the amount of group exposure, the participants in the mismatch condition were given another five minutes to come together and discuss the features they chose and to integrate the different steps into a single ritual practice. These instructions were meant to ensure that the mismatch participants felt like they were engaging in the same group ritual rather than individual ones. After the five minutes passed, the experimenter asked participants to line up shoulder-to-shoulder and perform their group's ritual together at the same time. This last step applied to participants in both conditions.

2.2.1 Items and Measures

After completing the group ritual, participants sat down at a private computer station to complete the survey. Participants were asked to rate their experience with the ritual performance and with their group members. First, they answered three questions related to the experience of the ritual (i.e., positive ritual attributions), on a 7-point scale ranging from 1 (*not at all*) to 7 (*extremely*): (1) "How enjoyable was the ritual?" (2) "How meaningful was the ritual?" and (3) How effective was the ritual?" Given the difference in content of the appraisals, and their poor-to-fair internal consistency (*Cronbach's* α = .70), I treated the three items as separate in subsequent analyses.

Second, participants answered eight questions of group affiliation/liking, on a 7-point scale: (1) "What is your overall impression of your group?" (2) "How much do you like your group?" (3) "How close do you feel to your group?" (4) "Overall, how much did you enjoy performing the ritual with your group?" (5) "How similar are you to the other members in your group?" (6) "How much do you think the members of your group care about your group's

general well-being?" (7) "How invested are the members in your group?" and (8) "How strongly bonded do you think your members are to your group?" I averaged these items to create a composite group liking score (*Cronbach's* α = .88). Participants also completed a Feelings Thermometer, ranging from 0 (*coldness towards group members*) to 100 (*warmth towards group members*), and a measure of general entitativity from 0 (*no overlap*) to 6 (*complete overlap*).

Third, participants were asked a single question relating to their predicted group performance on the upcoming task ranging from 0 (*not well at all*) to 7 (*extremely well*): "Based on the interaction you've had with your group thus far, how well do you think you'll do together on the upcoming task?" Once finished with the survey, participants returned to their groups for the competing task. The joint task was a basic reaction-time task that involved participants responding with key-presses to different stimuli that appeared on screen. To fit with the cover story of the experiment, and to enhance group involvement, participants were led to believe the task was related to joint coordination and combined group effort. After the task, the experimenter debriefed participants, revealing the true purpose of the experiment. Regardless of performance, all participants received equal credit and $5 pay.

3 Study 3 Results

A series of one-way ANOVAs were run to test for the predicted main effect of condition (match ritual vs. mismatch ritual). First, looking at the three positive ritual attribution ratings, there was a significant effect of condition on ritual ratings of enjoyment (F (1,185) = 19.66, p < .00001, η_p^2 = .09), meaning (F (1,185) = 8.39, p = .004, η_p^2 = .04), and effectiveness (F (1,185) = 60.16, p < .00001, η_p^2 = .25). In line with my predictions, participants who completed the matched sequences appraised the ritual and the experience as more enjoyable, meaningful, and effective, relative to those who completed the mismatched sequences. See Table 1 for all descriptive data.

Second, looking at the aggregate group affiliation score, there was also a significant effect of condition (F (1,185) = 14.01, p < .00001, η_p^2 = .07), indicating that participants who completed the matched sequences liked their group members more, relative to those who did the mismatched sequences. Mirroring the affiliation measures, I also found an effect for the Feelings

Thermometer measure (F (1,185) = 10.87, p = .001, η_p^2 = .06) and the group entitativity measure (F (1,185) = 14.67, p < .00001, η_p^2 = .07). In line with my hypotheses, these findings indicate that matched participants felt greater warmth towards, and enhanced self-other overlap with, fellow group members.

Third, looking at the task prediction item, there was again a significant main effect of condition (F (1,185) = 18.58, p < .00001, η_p^2 = .09), showing that the participants who completed the matched ritual sequences said they would do better together on the upcoming joint performance task, compared to those who completed the mismatched ritual sequences. Altogether, I find direct, causal support for the hypothesis that ritual is associated with heightened group functioning when group members' actions are matched; the level of group affiliation is reduced in the same type of actions that are enacted by group members in a mismatched manner. I next conducted a mediational test to test the prediction that the effect of ritual matching on group liking is driven by top-down appraisals of the overall ritual experience.

Table 1. Means (SD) for self-reported positive ritual appraisals, group evaluations, and predicted performance. Means across rows with different subscripts differ significantly at $p < .05$ (two tailed).

	Match Ritual Condition	Mismatch Ritual Condition
Dependent variable	M (SD)	M (SD)
Ritual appraisal		
Enjoyable	5.02_a (1.26)	4.22_b (1.20)
Meaningful	3.60_a (1.36)	3.03_b (1.33)
Effective	5.84_a (1.22)	4.26_b (1.55)
Group evaluations		
Affiliation/liking	4.81_a (1.06)	4.26_b (0.95)
Feelings thermometer	73.88_a (18.71)	65.29_b (16.91)
Entitativty	3.73_a (1.08)	3.45_b (1.04)
Predicted joint performance	5.35_a (1.17)	4.64_b (1.12)

3.1 Mediational analysis of ritual appraisals

To test whether top-down experience appraisals explain the effect of condition (matched vs. mismatched) on group affiliation, I fit the data to a parallel mediation model using the PROCESS add-in function for SPSS (Model 4; Hayes, 2013). First, however, I created a combined group affiliation score, standardizing and aggregating the original group affiliation score, Feelings Thermometer, and group entitativity measure. This was then used in the model as the main outcome variable. The significance of the total, direct, and relative indirect effects were tested using a bootstrap analysis with 5000 samples to obtain parameter estimates.

As is shown in Table 2, a 95% confidence interval that did not include zero indicated a statistically significant effect (Preacher & Hayes, 2008): The confidence intervals for the total effect mirror the above analyses showing an effect of condition on group affiliation; two separate significant indirect paths through meaning and enjoyment appraisals (but not through effectiveness rating) showed evidence of mediation in explaining the effect of the (mis)matching manipulation on group affiliation; and the non-significant direct effect indicated a full mediation effect – that is, the effect of condition on group affiliation was fully accounted for in participants' positive appraisals of the ritual. Figure 4 illustrates the effects.

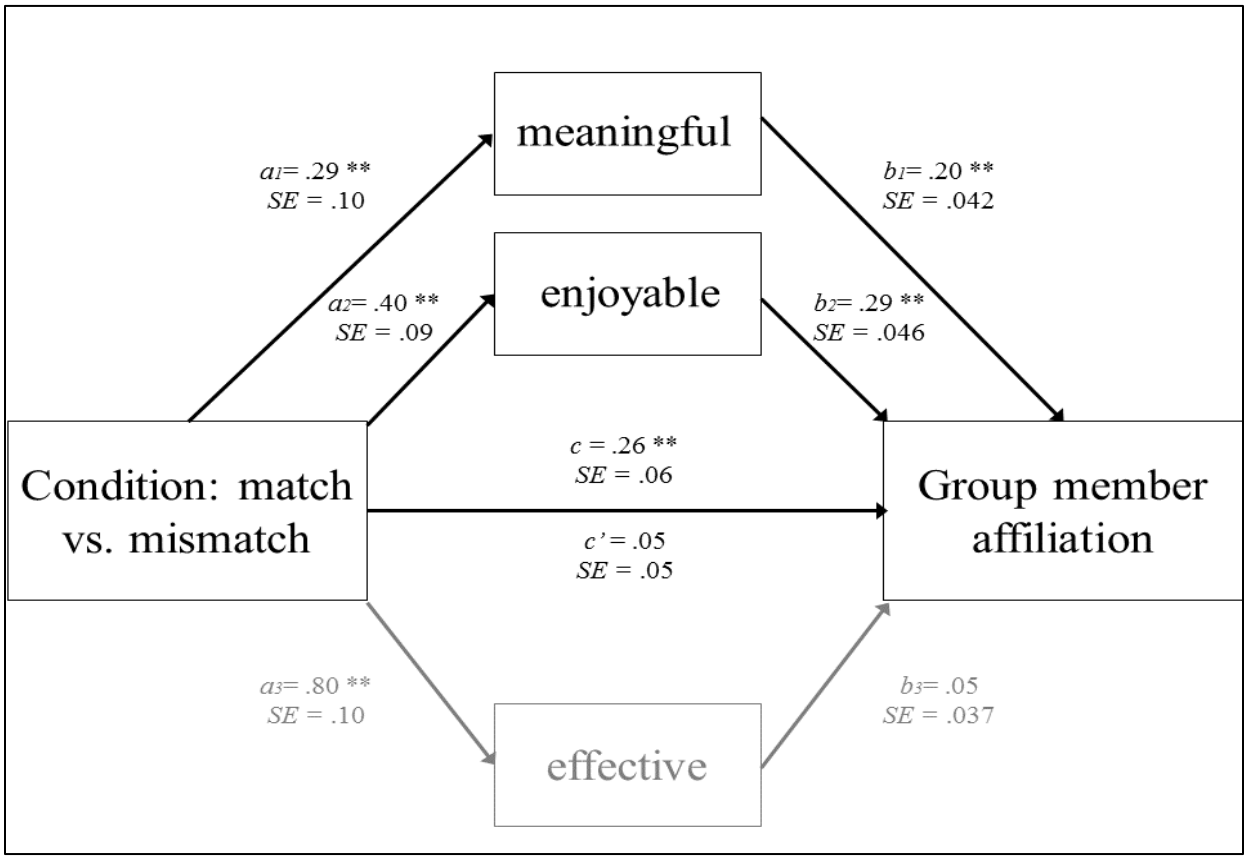
Taken together, here I find evidence that matched action sequences during ritual enhance group functioning, which is driven to a large extent by people's positive appraisals of the ritual experience. Demonstrating the effect in novel groups, and using novel actions, the findings show that physically matching with one's fellow members elicits feelings of enjoyment and meaning, which in turn boosts affiliative attitudes even within a novel and minimal group context.

Table 2. Results of the mediation analysis: Meaningful and enjoyable ratings act as a mediator of the effects of matching condition on group affiliation.

Mediation effects	*SE b*	95% CIs
Total effect	0.062	[0.11, 0.32]*
Direct effect	0.053	[-0.06, 0.15]
Indirect effect through meaningful	0.022	[0.02, 0.11]*
Indirect effect through enjoyable	0.033	[0.06, 0.19]*
Indirect effect through effective	0.029	[-0.02, 0.10]

Note. * $p < .05$.

Figure 4. Parallel mediation model of appraisals as a mediator of the relation between condition and group affiliation. Unstandardized regression coefficients from a bootstrap procedure indicated along the paths. Darker lines indicate significant indirect effects and mediation.



Note. ** $p < .01$, * $p < .05$.

4 Study 3 Discussion

In line with past research on behavioral synchrony, here I find evidence supporting my hypothesis that matched rituals are associated with heightened group functioning, compared to mismatched rituals. Furthermore, the predicted group liking effect in ritual appears to be driven by group members' positive attributions related to the ritual experience. Merely engaging in (arbitrary) matching actions makes a ritual experience more positive and meaningful, which in turn, boosts group affiliation. Together, this is initial evidence suggesting that synchrony is a mechanism by which ritual leads to group cohesion and liking. Ritual's parsed actions and rhythmic sequencing make synchrony and behavioral matching more likely, especially among large-sized groups. However, as observed here, as much opportunity as there is for successful matching during ritual, so too is there equal opportunity for failed mismatching. A group's attempt to engage in ritual for the purpose of strengthening group ties could end up backfiring, particularly if there is emphasis placed on the ritual script and strict synchronization.

There are two limitations to consider with respect to the above conclusions. First, the current experiment failed to include a no-ritual control condition. Without this baseline comparison, it is difficult to know for certain if matching ritual leads to more positive group functioning, and if mismatching ritual leads to more negative group functioning (or both). Second, although the (mis)matching manipulation involved a restricted set of actions to choose from, there might have been more creative involvement from the matching participants because they built the set of ritual actions together. To conclude with greater confidence that it is strictly the ritual actions themselves that are driving these effects, future tests would need to provide participants with a set list of pre-defined sequences to follow.

I am currently testing these predictions in a set of follow-up studies. Preliminary evidence confirms my predictions: Compared to a no-ritual control group, enacting in ritual is better for group cohesion but only if the actions match; even a single misstep in the sequence makes things worse for group cohesion and joint performance.

Chapter 4
Ritual Physical Style and Emotive Dynamics

1 Study 4 Introduction

Physical movement is a critical feature of collective ritual. In ritual, abstract thought is fused with concrete, outward directed action (Geertz, 1973). Indeed, the perceived efficacy of ritual is determined by their physical and motoric features, including repetition and sequencing of movement (e.g., Legare & Souza, 2012, 2014). We see in real life examples just how different rituals can look, physically. Comparing the ritual traditions of weddings versus funerals, which convey either extreme joy or sorrow, it is clear that the physical movements reflect these underlying emotive dynamics. Movements in wedding rituals are quick, light, and vivacious, whereas in funerals they are typically slow, heavy, and burdensome. It appears that there are different rituals for different group situations.

Here, I ask: Are physical movements in ritual linked to the emotional and motivational states associated with collective action? I suggest that ritual style (i.e., its physical movement) is non-arbitrary: The style of movement enacted during ritual conveys emotion and motivational states that regulate collective action. We might expect, for example, that in competition, a team wanting to convey a state of anger would engage in a certain style of ritual (e.g., fast-moving and erratic, instead of slow and predictable), as these are the ritual actions that would better prepare a group for a situation requiring an anger response.

If ritual's movements operate as a built-in regulatory mechanism, as I am suggesting here, then manipulating these bottom-up motoric features should produce differences in group functioning. One possible framework well-suited to test this idea is approach/avoidance motivation, a regulatory system responsible for managing various forms of action and affect (e.g., Carver, 2006). Approach and avoidance motivational forces have been shown to influence a range of different forms of affect, cognition, and behavior (Elliot, 1999; Elliot & Thrash, 2002). The two partially opposing motives are derived from an evolutionarily ancient system that mobilizes basic organismic activity (Tooby & Cosmides, 1990).

As motivational systems energizing behavior towards (or away from) certain goal states, approach/avoidance motives are expressed in embodied states including various bodily movements, postures, and facial expressions (e.g., Price & Harmon-Jones, 2015, 2016; Riskind

& Gotay 1982). Certain embodied states, like movements coming toward the person or urging forward, are associated with approach motivation and trigger positive affective processing; while other embodied states, like movements away from the person or holding back, are associated with avoidance motivation and trigger negative affective processing (Neumann & Strack, 2000). Thus, given the embodiment of approach/avoidance systems, in combination with ritual's involvement in regulating performance- and achievement-based outcomes (Elliot, 1999; Elliot & Church, 1997), it is reasonable to think that group ritual regulates performance by activating emotive states related to either approach/avoidance.

In performance domains where group rituals tend to occur, such as in athletics and military, it is common to think of two main types of strategic orientations: (i) the offensive strategy, where the focus is on gaining or taking away resources from some other group/team with increased attention to possible rewards; and (ii) the defensive strategy, where the focus is on protecting resources from being taken with increased attention to possible threats. The psychological tendencies present in offensive and defensive strategies (i.e., a fundamental basis of biased attention to rewards versus threats; Löw, Lang, Smith, & Bradley, 2008) map onto the broad motivational systems of approach and avoidance motivation, a parallel drawn by researchers in examining, for example, teamwork in corporate competitive environments (e.g., Woolley, 2011). Thus, I suggest that in group contexts, a team taking an offensive strategy will be more prone to engage in approach-motivated thinking and action, whereas a team taking a defensive strategy will be more prone to engage in avoidance-motivated thinking and action. I suspect these tendencies will translate over to variations in ritual style.

1.1 Hypotheses

I predicted that the motivational context will determine the type of ritual that is created and enacted. Specifically, I wondered if the types of preparation rituals people create (and engage in) differ depending on whether the group is assigned to an offensive versus defensive strategy. As mentioned, it is reasonable to think that an offensive style ritual will display physical movements consistent with approach-motivated tendencies, whereas a defensive style ritual will display movements consistent with avoidance-motivated tendencies. I tested the following prediction: An offensive strategy will lead to offensive-looking rituals (activating the approach system), and a defensive strategy will lead to defensive-looking rituals (activating the

avoidance system). If accurate, then independent observers should be able to tell, simply from viewing the constructed rituals, the motivational context in which the ritual was created.

1.2 Study 4 Methods

I recruited 29 participant groups (made up of 3-4 individuals per group) for course credit from the Rotman School of Management at the University of Toronto. Participants were told that the study was related to team building behaviors and group competition. They were assigned to either an offensive strategy or defensive strategy condition. One group's video data was removed from analyses because they failed to follow the instructions, leaving us with a final sample of 28 groups – 16 offensive and 12 defensive.

The groups were led to believe that they would be competing against another team in a lab-based military style game, where the goal of each group – or "country" – was to acquire and protect valuable resources. Prior to entering into the competition, I told groups that they would have twenty minutes to read over their assigned strategy and to build a ritual that would best reflect their assigned strategy. In reality, there was no other group or competition, but convincing participants otherwise was necessary in order to observe ritual behaviors that reflected the assigned strategies.

The groups received either offensive strategy instructions or defensive strategy instructions (see Appendix A for full instructions). The defensive strategy instructions indicated, for example, that the group would be starting out with more resources than the competing group, and that their goal was to protect these resources and prevent them from being taken. Opposite to this, the offensive strategy instructions indicated that the group would be starting out with zero resources, and that their goal was to steal the resources away from the competing group. Both groups were given the following instructions: "*The "rounds" of the game will test your group's physical strength/determination, collective intelligence, trusting behaviors, and strategic planning*." Participants were also told that before the competition would start, that they would need to come up with a "battle ritual" that best matched their team's strategy. Aside from the differences in defensive and offensive instructions, all other information and experiences were identical between the groups.

The groups were filmed as they created and performed their rituals in a separate lab room on their own. They were given twenty minutes to read over the instructions and create a ritual.

They were told that the ritual they came up with could involve any kind of physical movement or sequence. I wanted participants to have as much flexibility in creating the ritual so that the resulting actions were organic and spontaneous. As the end of the twenty minutes approached, participants were instructed to perform the finished version of their group's ritual one last time. Participants were fully debriefed and thanked for their participation.

1.3 Study 4 Results

The full twenty minute video clips were first cut down and edited to include only the segment of the final ritual performance. Across the different groups, the ritual videos ranged between 10-30 seconds in length. The ritual videos were compiled and shown to independent groups for three separate ratings/evaluations: (i) motivational context matching and strategy guesses, (ii) number of movements, and (iii) physical dimensions and emotion categories.

1.3.1 Context Matching

First, an independent sample of observers watched and rated the ritual videos. I predicted that people would be able to reliably discern (above chance) whether a group's ritual was created under an offensive or defensive set of strategy instructions. One-hundred and fifty five raters were recruited from Amazon's Mechanical Turk (83 males, 72 females, M_{age} = 36.95, SD_{age} = 11.82). The raters were told they would observe a number of small groups engaging in a ritual together that they did prior to engaging in a competitive task with another group. It was also revealed to raters that each group was given either a defensive strategy or an offensive strategy in the competition; the rater's job was to observe the actions of the ritual and to decide which set of instructions they thought the groups were provided. After watching each video, raters indicated their response of offensive strategy or defensive strategy. The data were logged with correct responses (i.e., matched strategies) coded as 1 and incorrect responses (i.e., mismatched strategies) coded as 0.

The coded data were combined and arranged as two case variables according to the two strategies. Two one-sample t-tests were run to determine if raters' decisions were better than chance guessing (.5), for both offensive strategy rituals and defensive strategy rituals. Results showed that raters' accuracy for discerning both styles of rituals was above chance, (offensive strategy: $t(234) = 4.49$, $p < .0001$, $M = .64$, $SD = .48$; defensive strategy: $t(209) = 3.70$, $p <$

.0001, M = .62, SD = .49). In line with my prediction, groups' ad-hoc rituals were created differently in accordance with the underlying motivational strategy assigned. An explanation for raters' ability to discern between the two ritual styles is that the offensive strategy led people to enact behaviors that appeared more approach-oriented, as expressed in a "movement toward" something positively evaluated (i.e., potential to gain rewards in the offensive position). And similarly, the defensive strategy could have led people to enact behaviors that appeared more avoidance-oriented, as expressed in a "movement away" something negatively evaluated (i.e., potential to incur losses in the defensive position).

1.3.2 Number of Movements

Second, to further support this claim, I had the videos coded by an independent rater blind to the study's purpose. The videos were coded for the amount of movement engaged by the individuals in the groups. Because approach-motivation may be thought of as activating increased movement towards a rewarding goal stimulus (i.e., an appetitive state), whereas avoidance-motivation may be thought of as an inhibition of movement (i.e., avoidance state), I suspected that the offensive rituals would show more movement than the defensive rituals. Three types of movements – head, arm, and leg – were coded using frequency counts for each person within the group. Supporting this prediction, analyses showed an effect of head movements, $t(72) = 3.13$, $p = .003$, arm movements, $t(72) = 2.92$, $p = .005$, and leg movements, $t(72) = 3.75$, $p = .0001$. Individuals engaging in offensive rituals moved their heads, arms, and legs more ($M_{heads} = 1.50$, $SD_{heads} = 1.49$; $M_{arms} = 10.05$, $SD_{arms} = 11.85$; $M_{legs} = 6.45$, $SD_{legs} = 6.45$) compared to individuals engaging in defensive rituals ($M_{heads} = 0.59$, $SD_{heads} = 0.89$; $M_{arms} = 3.97$, $SD_{arms} = 2.75$; $M_{legs} = 2.15$, $SD_{legs} = 1.93$).

1.3.3 Movement and Emotion Features

Third and final, to assess the differences in ritual style as a function of motivational context, a separate group of participants rated the rituals for how they looked both physically (five physical dimensions) and emotionally (six emotion categories). For the physical movements, I borrowed from previous work on movement and affective dynamics (Sievers, Polansky, Casey, & Wheatley, 2013). Participants provided ratings from 0 (e.g., *slowest moving*) to 10 (e.g., *fastest moving*) for five separate movement dimensions: (i) fast vs. slow, (ii)

regular/predictable vs. irregular/unpredictable, (iii) tilted back vs. tilted forward, (iv) lightness vs. heaviness, and (v) smooth/fluid vs. jerky/dissonant. For the emotion ratings, participants rated the emotional appearance of the group's movements from 0 (*not at all)* to 10 (*completely*) for six separate emotion categories: joy, sad, relief/peace, fear, anger, and pride.

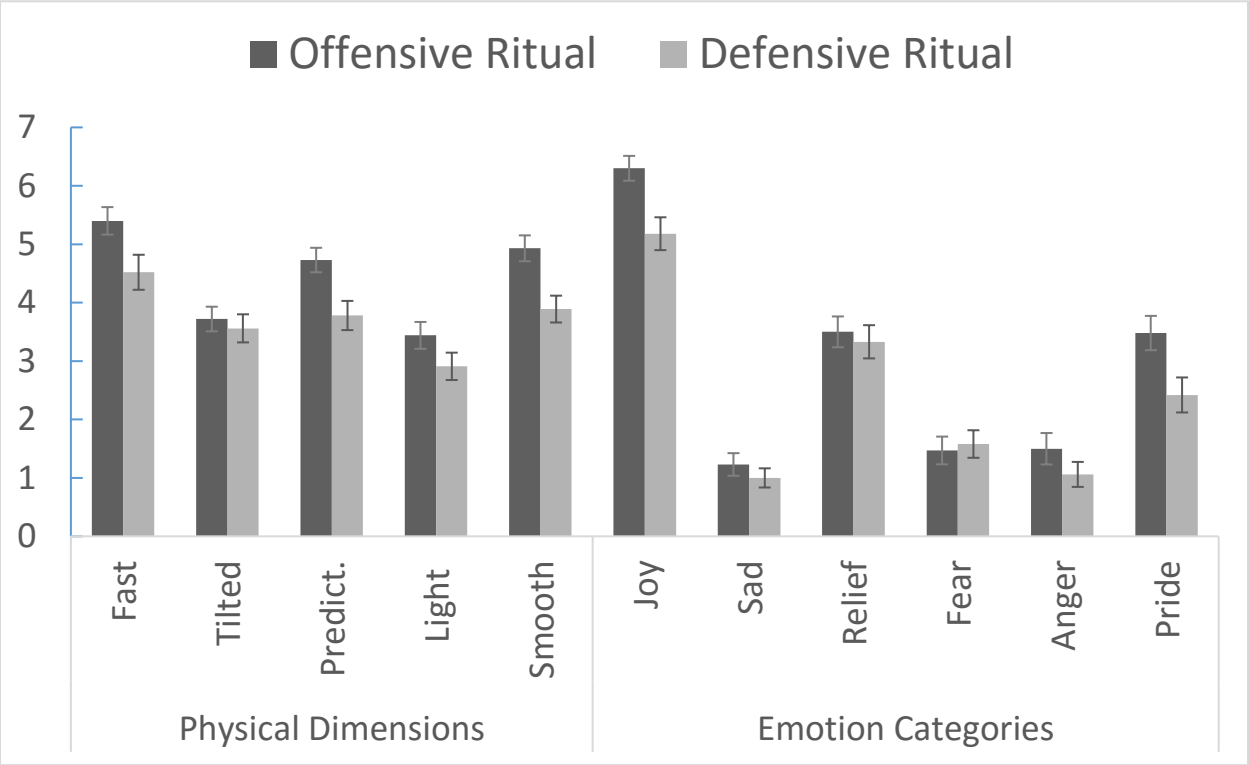
The rationale here was that since the rituals were perceived correctly as belonging to the appropriate motivational strategy, they should be rated differently in terms of their physical features and the emotions they convey. More specifically, if, as I are suggesting, the offensive rituals map onto approach-motivation, then these ritual actions should express more positive emotion states; and if defensive rituals map onto avoidance-motivation, then these ritual actions should express negative emotion states (e.g., Elliot, 2006).

A separate sample of 41 participants were recruited for course credit at the Rotman School of Management at the University of Toronto. They were asked to watch and rate the ritual videos using six physical dimensions and five emotion categories. The order in which they gave the ratings was counterbalanced, and the presentation of the video stimuli was randomized across participants. In addition to the physical features and emotions, raters were also asked two additional questions in response to each ritual video: (i) "How coordinated does the group appear?" and (ii) "How likely are they to cooperate with one another?" The data were aggregated across all ritual videos for each participant, resulting in thirteen variables (five physical dimensions, six emotion categories, and the two additional items listed above). A repeated-measures ANOVA was run on each variable to examine the difference in ratings between the offensive and defensive rituals.

Looking at the physical dimensions, offensive rituals (compared to defensive rituals) appeared faster (F (1, 40) = 14.20, $p < .00001$, $\eta_p^2 = .26$), lighter (F (1, 40) = 15.41, $p < .00001$, $\eta_p^2 = .28$), smoother (F (1, 40) = 23.43, $p < .00001$, $\eta_p^2 = .37$), and more predictable (F (1, 40) = 20.49, $p < .00001$, $\eta_p^2 = .34$). In line with our predictions, for the emotion categories, offensive rituals appeared more joyous (F (1, 40) = 30.82, $p < .00001$, $\eta_p^2 = .44$), angrier (F (1, 40) = 5.04, $p = .03$, $\eta_p^2 = .14$), and more proud (F (1, 40) = 17.32, $p < .00001$, $\eta_p^2 = .34$). Finally, the groups engaging in the offensive rituals appeared more coordinated (F (1, 40) = 16.23, $p < .00001$, $\eta_p^2 =$

.29) and more likely to cooperate with one another (F (1, 40) = 19.67, $p < .00001$, $\eta_p^2 = .33$. See Figure 5 for the displayed data. These findings suggest that rituals constructed under an offensive motivational strategy mobilize an approach-oriented mindset within groups, demonstrated by an increase in perceptions of positive emotion states including joy. This is further verified by the perceived presence of pride, which has been linked to approach motivation (Williams & DeSteno, 2008), as well as the presence of anger, a negatively valenced affective state also distinctly associated with approach (Carver & Harmon-Jones, 2009; Harmon-Jones & Allen, 1998; Harmon-Jones & Sigelman, 2001).

Figure 5. Mean ratings on physical dimensions and emotion categories for both offensive and defensive rituals. Error bars represent standard error of the mean.



1.4 Study 4 Discussion

Together, the three independent evaluations of the ritual videos confirm my predictions that (i) rituals are constructed differently depending on the motivational context (having an offense versus defense strategy), and (ii) these stylistic differences map onto either an approach-motivated or avoidance-motivated state. Thus, this is evidence to suggest that differences in ritual style – the physical features they are created from – are associated with the motivational and regulatory context in which the ritual is done. Collective rituals look a certain way for a reason: Their physical features align with the emotional and motivational demands required for a group to achieve shared goal or outcome.

One interesting thing to note is how groups with the offensive strategies were seen as more coordinated and more likely to cooperate with one another, compared to the groups with the defensive strategies. This is consistent with past research showing that approach motives are linked to more positive social outcomes including group bonding, whereas avoidance motives are linked to more negative social outcomes including fear of rejection and disconnect (Gable, 2005; Elliot, Gable, & Mapes, 2006; Gable & Strachman, 2008). This idea ties into the predictions that follow in the next study.

2 Study 5 Introduction

For Study 5 I wanted to extend the findings from Study 4 to further test the hypothesis that variations in ritual style impact not just perceptions of group functioning, but actual group behavior. The role of physical movement in ritual offers two competing explanations as a test for my hypothesis: The first would suggest that ritual style *is not* important and that a predicted outcome will follow from the enactment of any type of ritual (just so long as it is ritual). In contrast, the second explanation would suggest that ritual style *is* important and that the predicted outcome will depend on the style (i.e., the physical features) of the ritual being enacted. Pitting these two possible explanations against one another, the current study experimentally varies (i) the physical style of two types of ritual behaviors (approach motive style versus avoidance motive style) and (ii) the motivational context of the group (offensive versus defensive strategies), and tests for differences in group functioning and joint performance.

2.1 Hypotheses

The first possibility suggests that any form of ritual will do: Under a null, I should not see any differences in group behavior as a function of variations in ritual style. This prediction aligns with past work that uses similar lab-based rituals (Brooks et al., 2016; Norton & Gino, 2013). The researchers found that action sequences labeled as ritual predict changes in behavior, but the same actions labeled as random actions does not. According to this explanation, ritual style and the associated motivational context will not affect group functioning because both ritual actions (approach and avoid styles) are given the same ritual label and framing. This is the basis of the null hypothesis:

> *H0*: There will be no difference in group functioning/performance between groups who enact an approach style ritual and those who enact an avoidance style ritual, or between groups who have an offensive strategy and those who have a defensive strategy.

From the second explanation, there are two possible hypotheses. If physical style of a ritual matters for regulating a group's performance, then the style of ritual should match the motivational state associated with the performance context. This matching up of a person's

current state to the motivational context may facilitate effective performance in ritual. That is, motivational matching (or mismatching) will align (or misalign) performance with goal states and lead to better (or worse) performance. This idea, referred to as the motivational congruency effect, has been shown with individual differences in approach/avoidance orientation. For example, approach-oriented people have been shown to engage in more effective health behaviors when given a gain-framed message compared to avoidant-oriented people who engage in more effective health behaviors when given a loss-framed message (Mann, Sherman, & Updegraff, 2004; Sherman, Mann, & Updegraff, 2006). This idea of motivational congruency leads to my first test hypothesis:

> *H1a*: Ritual styles (approach versus avoidance) that match the motivational context (offensive versus defensive) will result in heightened group functioning; groups will perform better when the physical actions of the ritual align with the assigned strategy (ex. approach style actions and offensive strategy) than when the actions and strategy misalign (ex. avoidance style actions and offensive strategy).

The second possible prediction for our alternative explanation is that approach-oriented (versus avoidance-oriented) actions generate positive group outcomes irrespective of any assigned strategy and congruency (mis)matching. Since approach motives are associated with positive group interactions (Gable, 2005), a ritual that generates an approach mindset will benefit group performance even under incongruous conditions. I arrived at this alternative prediction based on the ratings from Study 5, which revealed that the groups engaging in offensive/approach actions were perceived as more cooperative and coordinated relative to those engaging in defensive/avoidance actions. This leads to my second test hypothesis:

> *H1*b: Regardless of the assigned strategy (offensive versus defensive), and whether the actions match the motivational context, approach style ritual actions will lead to heightened group functioning. In all cases, groups will perform better after doing an approach style ritual than after doing an avoidance style ritual.

2.2 Study 5 Methods

2.2.1 Participants and Power Analysis

A power analysis using *G*Power* (Faul, Erdfelder, Lang, & Buchner, 2007) was run to determine adequate sample size. With a between-subjects design, and assuming the typical moderate effect size in social psychology (i.e., $r = .21$, $d = .43$; Richard, Bond, & Stokes-Zoota, 2001), I determined that a total sample size of 230 participants yields a power value of 0.90 for detecting the possible omnibus univariate main effects and two-way interaction. I therefore decided to stop data collection around this point.

Two-hundred and twenty six University of Toronto undergraduate students (65% females; *mean age* = 19.8, *SD* = 2.43) participated for course credit and the opportunity to earn extra bonus pay based on group performance. They were told that the group that performed the best (as determined by most points accumulated in a joint task) would get the chance to earn a possible extra $30.

2.2.2 Procedure

Participants arrived to the lab in groups of either four or six, depending on how many student signed up on the online portal system. They were each randomly assigned before the start of the experiment to one of two teams. The teams consisted of either two participants each (4 person sessions) or three participants each (6 person sessions). Participants were told that the purpose of the study was related to teamwork and group competition. They were given the following instructions:

> *For this study, you will be assigned to a group and together, you will learn and memorize a set of ritual action sequences, which are thought to be associated with various cognitive, emotional, and memory processes. Afterwards, you will answer a series of questionnaires and compete with another group.*

The two teams of participants were brought to their own rooms and given further instructions on how to complete the action sequences. They were told they would learn the ritual actions together prior to doing the competitive task. In a between-subjects 2 (ritual style:

approach-oriented vs. avoidance-oriented) X 2 (strategy: offensive attack vs. defense guard) full-factorial design, participant groups were assigned to one of four conditions: (1) Approach ritual/Offensive attack, (2) Approach ritual/Defensive guard, (3) Avoidance ritual/Defensive guard, and (4) Avoidance ritual/Offensive attack. Conditions 1 and 3 were matched, with the ritual style aligning with the assigned task strategy; in contrast, conditions 2 and 4 were mismatched, with the ritual style opposite to the assigned task strategy. This full facotiral design allowed us to adequately test all three hypotheses.

Both ritual sequences were a minute and a half long. They consisted of five or six separate movements repeated four times (see Appendix B for the written steps of the sequences). I determined the specific styles of the approach and avoidance rituals – the actual physical movements – using the constructed rituals from Study 4. I searched through both offensive and defensive rituals from this study and made note of the features that appeared most approach-motivated and most avoidance-motivated. This was informed by past research on posture and bodily movement and motivation: The association between whole body postural displays and approach/avoidance motivation shows that approach states are typically associated with movements of pushing ahead, including standing upright, outstretching arms/legs, and leaning forward; while avoidance states are typically associated with movements of guarding and holding back, including pushing away and standing in a slumped posture (Harmon-Jones, Gable, & Price, 2011; Price & Harmon-Jones, 2010, 2016; Riskind, 1984; Riskind & Gotay, 1982). The two rituals were created with these features in mind.

I conducted a piloted pretest using an independent sample (N=36) to confirm that the two ritual styles that I created were perceived as different in terms of the physical dimension and emotion ratings, and also, that they contained the features consistent with either approach-motivation (for offensive style rituals) or avoidance-motivation (for defensive style rituals). Analyses from the paired sample t-tests (one-tailed) revealed patterns similar to the above analyses in Study 4: The offensive/approach ritual, compared to the defensive/avoidance ritual, was rated as faster ($t(35) = 3.88$, $p < .0001$) and smoother ($t(35) = 3.57$, $p = .0005$; the offensive/approach ritual was also rated as more joyous ($t(35) = 3.15$, $p = .002$), less sad ($t(35) = -2.56$, $p = .008$), more content ($t(35) = 1.58$, $p = .06$), less fearful ($t(35) = -2.47$, $p = .001$), and more prideful ($t(35) = 1.64$, $p = .05$). Finally, the approach style ritual was correctly guessed

(above chance) as a set of actions belonging to an offensive strategy ($t(35) = 3.42$, $p = .002$); the avoidance-style ritual was also correctly guessed as a set of actions belonging to a defensive strategy ($t(35) = 5.92$, $p < .00001$).

Before completing the action sequences, the rules of the competition were explained to both groups of participants. In each experimental session, there was always one offense team and one defense team. Participants were given the following instructions:

> *Today you will be facing off in a competition. The strategies and tactics your team uses will depend on whether you're on the offense or defense. There are multiple battle rounds in the competition and they will happen in separate rooms on the computers. The group that wins will get the chance to earn extra money, which will be compared against all other teams over the duration of the entire experiment.*

The groups were then asked to complete their ritual. They were provided with the written steps as well as a video model that they could follow along with. Groups were given ten minutes to learn the steps together and asked to do a final run-through before the start of the competition task. The research-assistant monitored the progress and timing of the groups to ensure that each group received the same amount of preparation time together. After ten minutes of practicing, groups began the competition task.

2.2.3 Collective Performance Task

The task, called the Tower and Gate Game, involved coordinated decision-making in nine "battle" rounds. The Tower and Gate Game, a task based off of the principles of game theory, is a military style strategist game in which teams consider rational trade-offs in attempt to secure the most amount of battle points (beating out the opposing team). The defense army team started out with twenty resource points, and their job was to guard the castle and hold onto as many of the resources as possible; at the same time, the offense team's job was to breach the castle and steal as many of the resources away from the defense team. In each round, the offense team had to collectively agree and decide which target of the other team to attack – either the tower or gate. At the same time, the defense team had to collectively agree and decide to guard one of

these areas (note, teams could not mix both in a single round decision; it was either the tower or the gate, not both).

An offense team win (taking resource points) would mean choosing to attack the targeted area (e.g., the gate) while the defense team guarded the other area (e.g., the tower). Conversely, a defense team win (holding onto resource points) would mean choosing to guard the targeted area (e.g., the tower) that the offense team attempted to attack (e.g., the tower). Critically, the gate was considered the higher-stakes (but riskier) option, as it returned more resource points if the offense team's attack was successful, and also ensured the protection of more points for the defense team if their guard was successful (see supplemental materials for the full instructions given to participants). The primary goal of each group was to try and out-strategize the other team by predicting their decisions beforehand. For the offense team this meant choosing the opposite location, and for the defense team this meant choosing the same location. See Appendix C for the full instructions given to participants from both groups.

The resources, either stolen or guarded by the offense team or defense team, respectively, were tracked across the nine rounds. Groups attempted to finish the game with as many points as possible. The more points a group had at the end of the competition, the better chances they had at earning extra bonus money.

The start of each round was announced in an online chat forum that both groups could see. Group members discussed their options and entered the final decision (attack the gate/tower vs. defend the gate/tower) into the chat space using pre-designated code words. A research assistant in a control room entered the decision codes into an excel calculator. The winner/loser of each round was determined and the points lost/gained was then calculated. At the completion of each round, the research assistant displayed the outcome of the battle in the chat space to both teams. This was repeated nine times, once for each round.

2.2.4 Items and Measures

After completing the ritual sequences, and prior to starting the task, participants were asked to report how the felt heading into the competition. They were given the following instructions: *Please indicate the extent to which you think your group feels right now.* Using a scale from 1 (*not at all*) to 7 (*completely*), participants responded to the question, "We feel a

sense of [*item here*],” with the six separate emotion categories including joy, sadness, relief, anger, fear, and pride.

Before displaying the outcome of each round, participants individually rated how they felt about the group’s decision on a scale from 1 to 7. They were asked: “How happy are you with your group’s [*round number*] decision?” (1 [*Extremely unhappy*] to 7 [*Extremely happy*]); “How easy/difficult was it for your group to decide on [*round number*]?” (1 [*Very difficult*] to 7 [*Very easy*]); and “What is the likelihood of your group winning [*Round number*]?” (1 [*Very unlikely*] to 7 [*Very likely*]). Participants responded to these questions nine times, after finishing each round. The three sets of ratings were averaged and used in analyses to compare between each of the conditions.

After the final round, but before the winner was announced, participants answered a final set of questions about the experience with the task and their group. First, participants were asked to predict their group’s overall success in the competition. They responded to the following questions: “Do you think your group won the competition?” (1 [*Definitely yes*] to 5 [*Definitely not*]); and “How many points do you think your group finished with?” (selecting an integer value from a dropdown list).

Participants then rated what they thought of their group’s teamwork and effectiveness during the task, on a scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*). The questions included: (1) “Our group cooperated well during the round’s discussion” (2) “There was a lot of disagreement and conflict within our group during the discussions” (reverse scored) (3) “Our group worked well together during the discussions” (4) “There was a lot of trust between our group members” and (5) “Our group just seemed to “click” and work well together.” Participants also rated thirteen items on group entitativity/liking on a scale of 1 to 7. Examples of the items included: (1) “We performed as one, like a single person” (2) “How close do you feel to your group?” and (3) “How strongly bonded are you to your group?” The items from the two sets of measures – group effectiveness and group entitativity – were combined and the aggregate scores used in subsequent analyses (*Cronbach’s* α = .86 and .95, respectively).

Participant groups were notified of the final score in the competition. Their data were logged. These final performance scores were also used in the analyses. Participants were then fully debriefed, given the opportunity to ask any questions and thanked for their participation.

2.3 Study 5 Results

Following data collection I noticed an unexpected pattern in the types of choices made by many of the defense strategy groups. As mentioned, the gate choice was the higher stakes option because it returned a greater number of resource points to the offense team if successfully breached, and equally, ensured the protection of more points for the defense team if successfully guarded. Because of this, a reasonably safe strategy for a defense team would have been to choose the gate option every round, irrespective of the offense team's prior choices and performance. While almost guaranteeing a defense team win for the direct competition (securing a moderate amount of points relative to the offense team), such a safe defense strategy made it very unlikely for a group to finish with lots of points. Recall, I told participants that the team with the most points across all lab sessions would win extra bonus pay.

When designing the task, I did not expect most defense groups to adopt the safe (repeated choice) strategy, rather I expected to see more of a natural variation in this and the riskier (non-repeated choice) strategy. Clearly, this was not the case. As a result, a majority of defense teams finished with more points than the offense teams, and participants quickly became aware of the likely imbalanced outcome as the task progressed. It is reasonable to assume that this experience had an impact on participants' experiences and associated responses. This is a possible confound that needs to be addressed.

Despite the unexpected advantage experienced by many of the defense teams, the findings indicated that the winning (defensive strategy) had much less of an impact than the actual style of ritual done beforehand. As a whole, the type of ritual done prior to the competition seemed to matter more than the inadvertent winning (vs. losing) strategy. I expand on each set of analyses below. Table 3 includes the descriptive data for all the items.

Table 3. Means (SD) for all self-report data and collective performance (points eared across the competition). Means across rows (within each strategy condition) with different subscripts differ significantly at $p < .05$ (two tailed).

	Defensive Stategy		Offensive Stategy	
Dependent variable	Avoidant style ritual	Approach style ritual	Avoidant style ritual	Approach style ritual
Emotion categories				
Joy	4.31_a (1.58)	5.04_b (1.49)	4.56_a (1.22)	4.95_a (1.22)
Sadness	1.97_a (1.31)	1.47_b (0.82)	2.10_a (1.34)	1.95_a (1.30)
Relief	3.76_a (1.67)	4.34_b (1.74)	3.92_a (1.49)	4.25_a (1.65)
Pride	3.40_a (1.72)	4.26_b (1.73)	3.69_a (1.43)	4.35_b (1.63)
Fear	1.90_a (1.39)	2.00_a (1.58)	2.23_a (1.41)	2.00_a (1.41)
Anger	1.62_a (0.95)	1.66_a (1.17)	1.94_a (1.36)	1.66_a (1.14)
Decision happy	4.87_a (0.92)	5.35_b (1.26)	4.75_a (1.04)	4.97_a (0.95)
Decision ease	4.93_a (1.09)	5.44_b (1.31)	4.95_a (1.26)	5.19_a (1.08)
Winning rounds prediction	4.48_a (0.83)	4.59_a (1.21)	4.36_a (1.06)	4.69_a (0.98)
Predict performance (points)	14.28_a (5.16)	14.28_a (4.40)	10.31_a (4.80)	11.00_a (4.58)
Actual performnace (points)	12.17_a (5.05)	12.94_a (4.34)	7.76_a (2.67)	9.88_b (4.29)
Group effective	5.60_a (1.12)	6.01_b (0.79)	5.40_a (1.38)	5.83_b (0.80)
Group liking	4.51_a (1.05)	5.14_b (1.03)	4.58_a (1.33)	4.81_a (1.09)

2.3.1 Collective Emotion Ratings

First, a 2 (approach-oriented ritual vs. avoidance-oriented ritual) X 2 (offensive strategy vs. defensive strategy) factorial ANOVA was done on participants' impressions of their group's emotional state after completing the action sequences (but before starting the competition). Results revealed a main effect of ritual style on joy ($F(1, 220) = 9.00$, $p = .003$, $\eta_p^2 = .04$), sadness ($F(1, 220) = 3.87$, $p = .05$, $\eta_p^2 = .017$), relief ($F(1, 219) = 4.26$, $p = .04$, $\eta_p^2 = .019$), and pride ($F(1, 220) = 12.14$, $p = .001$, $\eta_p^2 = .05$. That is, across the assigned strategy conditions, participants who completed the approach style actions said their group felt a greater sense of happiness, pride, and relief, compared to the participants who completed the avoidance style actions. There were no effects involving fear ($F(1, 220) = 0.78$, $p = .38$, $\eta_p^2 = .004$) or anger ($F(1, 220) = 1.05$, $p = .31$, $\eta_p^2 = .005$). There were no other significant main effects involving the strategy condition or associated interactions (all *ps* > .25).

2.3.2 Competition Appraisals and Performance

Examining participants' appraisals and prediction in between the rounds of competition, a similar 2X2 factorial ANOVA revealed that ritual style predicted how happy people felt with their group's decisions ($F(1, 219) = 6.49$, $p = .012$, $\eta_p^2 = .029$) and how easy it was to come to the decisions ($F(1, 219) = 5.43$, $p = .02$, $\eta_p^2 = .024$). This same effect was non-significant for predicting the likelihood of winning the rounds, but in the expected direction ($F(1, 219) = 2.54$, $p = .11$, $\eta_p^2 = .01$). That is, the groups who did the approach-oriented ritual, relative to those who did the avoidance-oriented ritual, were happier about the group decisions ($M_{approach} = 5.17$, $SD_{approach} = 1.03$; $M_{avoidance} = 4.81$, $SD_{avoidance} = 1.07$), felt the decisions were easier to make ($M_{approach} = 5.31$, $SD_{approach} = 1.15$; $M_{avoidance} = 4.94$, $SD_{avoidance} = 1.22$), and marginally more likely to predict that they would win the rounds ($M_{approach} = 4.64$, $SD_{approach} = 1.00$; $M_{avoidance} = 4.42$, $SD_{avoidance} = 1.06$).

The only other effect was a marginal main effect of strategy condition on happy decisions ($F(1, 219) = 3.48$, $p = .075$, $\eta_p^2 = .014$), where participants who were given the defensive strategy

indicated they were happier with the group decisions than participants given the offense strategy ($M_{defensive}$ = 5.11, $SD_{defensive}$ = 1.06; $M_{offensive}$= 4.86, $SD_{offensive}$= 1.04). However, the assigned strategy did not predict ease of decisions or winning predictions (*ps* = .49 and .94, respectively). None of the interactions were significant.

I next ran the same analyses but with participants' final predictions of their performance, after all nine rounds finished. As before, there was a significant main effect of ritual style on participants' expectation of winning overall, $F(1, 217) = 5.49$, $p = .02$, $\eta_p^2 = .025$, in which participants who completed the approach style ritual were more confident in their chances of winning ($M_{approach}$ = 2.68, $SD_{approach}$ = 1.30) relative to those who completed the avoidance style ritual ($M_{avoidance}$ = 3.08, $SD_{avoidance}$ = 1.29). Not surprisingly, there was a very large effect of strategy condition on winning expectation, $F(1, 217) = 49.91$, $p < .00001$, $\eta_p^2 = .187$, and on total points estimated, $F(1, 217) = 31.73$, $p < .00001$, $\eta_p^2 = .128$. That is, participants given the defense strategy, compared to those given the offense strategy, reported much greater confidence in their winning ($M_{defensive}$ = 2.26, $SD_{defensive}$ = 1.29; $M_{offensive}$ = 3.50, $SD_{offensive}$ = 1.30) and predicted they would finish with more points ($M_{defensive}$ = 14.28, $SD_{defensive}$ = 4.76; $M_{offensive}$ = 10.66, $SD_{offensive}$ = 4.79).

Finally, the results of actual performance and accumulated points in the competition mirror the above analyses. Again confirming the presence of a defensive strategy advantage, there was a main effect of strategy condition on performance, $F(1, 204) = 40.44$, $p < .00001$, $\eta_p^2 = .165$. On average, defensive strategy groups finished with more final points ($M_{defensive}$ = 12.56, $SD_{defensive}$ = 4.22) than offensive strategy groups ($M_{offensive}$ = 8.82, $SD_{offensive}$ = 4.25). Similar to the above findings, there was also a main effect of ritual style, $F(1, 204) = 6.04$, $p = .015$, $\eta_p^2 = .029$. Participants who did the approach style ritual to start, ended up performing better in the end ($M_{approach}$ = 11.41, $SD_{approach}$ = 4.23) compared to participants who did the avoidance style ritual ($M_{avoidance}$ = 9.97, $SD_{avoidance}$ = 4.23).

The results suggest that as the competition was unfolding, what predicted participants' positive experience with group decisions was not whether they had the defensive strategy advantage, but whether they had engaged in the approach style ritual beforehand. In the middle of the competition, doing the approach ritual (instead of the avoidance ritual) seemed to matter

more than having the defensive strategy, even though the people equipped with the defensive strategy had an advantage, predicted they would win, and in fact won more often. In other words, having the "winning" strategy (the defensive strategy) did not necessarily make people feel good about the group's collective decisions; what mattered more was if an approach style ritual was completed before the competition even began.

2.3.3 Group Evaluation Measures

Last, looking at measures of group effectiveness, the model revealed a main effect of ritual style, $F(1, 218) = 9.47$, $p = .002$, $\eta_p^2 = .042$, in which participants who enacted the approach style ritual reported feeling their group was more effective during the competition ($M_{approach} = 5.93$, $SD_{approach} = 1.04$) compared to those who did the avoidance style ritual ($M_{avoidance} = 5.50$, $SD_{avoidance} = 1.04$). In the same vein, a main effect of ritual style on group liking ($F(1, 218) = 8.25$, $p = .004$, $\eta_p^2 = .036$) showed that participants who did the approach style ritual also reported liking their group more ($M_{approach} = 4.98$, $SD_{approach} = 1.13$) than those who did the avoidance style ritual ($M_{avoidance} = 4.54$, $SD_{avoidance} = 1.13$). The assigned strategy did not predict group effectiveness ($F(1, 218) = 2.00$, $p = .17$, $\eta_p^2 = .008$) or group liking ($F(1, 218) = 0.89$, $p = .40$, $\eta_p^2 = .003$).

2.3.4 Mediation Analysis

Last, to test whether group rating measures (i.e., group effectiveness and group liking) explained ritual's influence on performance, I fit the data to a parallel mediation model using PROCESS add-in function for SPSS (Model 4; Hayes, 2013). The significance of the total, direct, and relative indirect effects were tested using a bootstrap analysis with 5000 samples to obtain parameter estimates and 95% confidence intervals (Peacher & Hayes, 2008). I found a significant indirect effect through group effectiveness ($\beta = -.46$, 95% CIs [-1.00, -.14]) but not through group liking ($\beta = -.09$, 95% CIs [-.48, .13]). The significant total effect ($\beta = -.55$, 95% CIs [-1.05, -.17]) dropped to non-significant after accounting for the mediators in the model ($\beta = -.55$, 95% CIs [-1.76, .65]), suggesting a full mediation effect whereby group effectiveness explained the effect of ritual style on heightened performance.

2.4 Study 5 Discussion

Together, I have reason to reject the null hypothesis that differences in ritual style do not matter. Instead, the findings show support for Hypothesis 1b, suggesting that starting off the competition by doing an approach style ritual (compared to an avoidance style ritual) heightened the overall group experience and actual performance during the competition. Regardless of the strategy given, participants who did the approach style ritual at the beginning reported: (i) feeling happier, more relieved, and a greater sense of pride heading into the competition, (ii) more satisfied with the individual round decisions, (iii) a greater sense of ease with the decisions, (iv) a heightened level of group effectiveness and group liking, and (v) an enhanced likelihood of winning the competition. These groups also ended up performing better, finishing with more points overall, with heightened performance mediated by enhanced perceptions of group effectiveness.

It is interesting to note that these patterns emerged despite the (unplanned) clear advantage for the defensive strategy groups. The defensive advantage led participants in these groups to predict a winning performance and to finish with higher points. But despite the obvious benefit of having a much higher chance of winning (and earning extra money as a group), the winning strategy did not predict whether participants felt good about the decisions or whether they liked their group members more. However, an approach ritual style did predict these favorable outcomes.

In sum, here I find evidence supporting my second explanation laid out at the beginning of the study: The style of physical actions in ritual matters for regulating collective performance. Depending on the regulatory needs of a group, physical features of a ritual will facilitate the effective action required to achieve a desired outcome. Indeed, the findings suggest that there are different rituals for different situations. Of course, there are numerous ritual styles in real life; and because the current investigation framed two types of ritual using approach/avoidance, I cannot safely rule out the motivational matching hypothesis as a viable explanation. Looking at multiple types of group contexts and motivational features, future work will allow us to understand why rituals look (physically) the way they do. Uncovering the dynamics of collective ritual might also improve our understanding of group functioning more broadly.

Chapter 5
Ritual and Anxiety: Neural Response to Performance Failure

1 Study 6 Introduction

Rituals often precede important tasks and performance events, such as games, sports competitions, military operations, presentations, and tests. Ethnographic research has documented the importance of these rituals: Anthropological evidence from ancestral cultures finds that taboo rituals – those which prescribe rules of conduct and order – tend to increase during times of dangerous hunting/fishing performances (Malinowski, 1954); professional and amateur athletes feel compelled to do the exact same warm-up ritual before every game (e.g., Rotella & Cullen, 1995); military culture espouses disciplined excellence through ritualistic training programs (e.g., McNeill, 1995); and even popular blog posts, with titles like "The Value of Ritual in Your Workday" (Bregmen, 2010), give readers advice on how to utilize rituals for achieving small, day-to-day goals (e.g., Reynolds, 2011). Despite the ubiquity of performance rituals, very little is actually known about how these behaviors influence goal-directed performance, if at all.

Empirical evidence has shown that rituals serve a regulatory function by enhancing performance. Research shows, for instance, that performing rituals during athletic events, like right before shooting a free-throw in basketball, helps players perform better (Czech, Ploszay, & Burke, 2004; Lobmeyer & Wasserman, 1986; Predebon & Docker, 1992), especially in high-stakes competition and stress (Gayton, Cielinski, Francis-Keniston, & Hearns, 1989; Wrisberg & Pein, 1992). Rituals help improve performance because they mobilize motivational and regulatory states, either through improving concentration, creating physical readiness, or boosting confidence (Foster & Weigand, & Baines, 2006; Weinberg, Gould, & Jackson, 1979).

Adding to this, experimental research has shown that activating superstitious concepts – irrational cognitions frequently found in different rituals – leads to improved performance by making people feel like luck is on their side, thereby boosting feelings of self-efficacy and confidence (Damisch, Stoberock, & Mussweiler., 2010; but see Calin-Jageman & Caldwell, 2014 for a failed direct replication of these effects). Like superstitious thinking, rituals may improve performance by fostering personal confidence and positive performance expectations, which in turn, leads to greater success on the ensuing task.

A very recent set of studies demonstrated that people tend to perform better on a range of tasks when engaging in an arbitrary ritual beforehand, but only when the actions are labeled as ritual. The researchers found evidence that participants' improved performance was explained by a reduction in self-reported anxiety (Brooks, Schroeder, Risen, Gino, Galinsky, Norton, & Schweitzer, 2016). It has long been inferred that rituals – particularly religious rituals – can act as a palliative against anxiety and failure. Indeed, evidence suggests that paying attention to the chunked and predictable action sequences of a personal ritual can act as a compensatory strategy to help regain control when experiencing anxiety (Boyer & Liénard, 2006; Norton & Gino, 2013).

But how do such arbitrary sequenced behaviors impact goal-regulation, performance, and anxiety? What neuropsychological mechanisms underlie these types of rituals? To gain insight into this puzzling motivational process, we can consider *how* the underlying mechanisms of ritual are driven by brain-based regulatory control, specifically the neural performance-monitoring system.

1.1 Neural Performance-Monitoring, the ERN, and Ritual

As a candidate proximal mechanism underlying the ritual-performance link, I expect to see changes in neural performance-monitoring, especially when considering its involvement in tracking motivationally relevant performance outcomes. Here, I wondered whether ritual's regulatory function can be traced either to heightened performance-monitoring (an orienting to failure), or to reduced performance-monitoring (minimizing reactivity to failure).

Offering a test of these predictions, when a person experiences some sort of performance failure, they tend to exhibit a distinct neurophysiological response, which indicates that such failures are not only monitored and detected but also responded to emotionally (Inzlicht & Al-Khindi, 2012) and perhaps with personal distress (Hajcak & Foti, 2008). A common neural correlate of this monitoring system is the error-related negativity (ERN), an electroencephalographic waveform believed to arise from the dorsal region of the anterior cingulate cortex (Bush, Luu, & Posner, 2000; Dehaene, Posner, & Tucker, 1994; Gehring, Goss, Coles, & Meyer, 1993; Mathalon, Whitfield, & Ford, 2003). As a generic, multi-modal signal of the performance-monitoring system, the ERN is thought to be related to reinforcement learning (Holroyd & Coles, 2002) and conflict monitoring (Botvinick, Braver, Barch, Carter, & Cohen,

2001; Yeung, Botvinick, & Cohen, 2004), reflecting the discrepancy between an expected outcome and an actual outcome (Holroyd & Coles, 2002). It emerges between 50 and 100 milliseconds after an error is committed.

Importantly, recent work has shown that the ERN may reflect not only the detection of errors, but also the affective and motivational salience of performance failure, error, and conflict (e.g., Hajcak, Moser, Yeung, & Simons, 2005; Hobson, Saunders, Al-Khindi, & Inzlicht, 2014; Inzlicht, Bartholow, & Hirsh, 2015; Proudfit, Inzlicht, & Mennin, 2013; Weinberg, Riesel, & Hajcak, 2012). According to this view, the signal strength of the ERN may partially reflect an evaluative appraisal of error or response conflict, with differences in ERN magnitude mapping onto the sensitivity to performance failure and regulatory control.

Facilitating effective control during performance, the ERN is thought to be involved in the detection of conflict/error (e.g., Botvinick et al., 2001), the openness to experiencing aversive performance error (e.g., Legault & Inzlicht, 2013), and the affective or evaluative response to that performance error (e.g., Bartholow, Henry, Lust, Saults, & Wood, 2012; Hajcak & Foti, 2008; Saunders, Rodrigo, & Inzlicht, 2016). Critical to the test of our current hypotheses, we can map the differences in ERN activation onto the explanation of ritual's predicted regulatory function. On the one hand, larger ERNs tend to reflect heightened performance and error monitoring (van Veen & Carter, 2002), an internally driven mechanism optimizing performance by signaling the need for remedial control (Carter, Braver, Barch, Botvinick, Noll, & Cohen, 1998). If rituals evoke a sense of personal mastery, then we should see an increase in performance-monitoring with increased motivation to detect potential sources of failure (i.e., a larger ERN).

On the other hand, smaller ERNs tend to reflect a blunted affective response to personally distressing information like errors and performance failures (Maier, Scarpazza, Starita, Filogamo, & Làdavas, 2016), the opposite being expressed in people with anxiety disorders and high trait anxiety/worry (Hacjcak, McDonald, & Simons, 2003; Olvet & Hajcak, 2009; Weinberg & Hajcak, 2011). If, as some evidence has suggested, rituals appear capable of reducing anxiety and mitigating uncertainty, then it is equally plausible that ritual leads to a decrease in performance-monitoring (i.e., a smaller ERN). A possible downside, of course, is that this type

of blunted neural evaluation of errors might end up hurting performance rather than helping it (e.g., Hobson, Saunders, Al-Khindi, & Inzlicht, 2014; Ridderinkhof et al., 2002).

1.2 Hypotheses

Here, in an openly pre-registered experiment (https://osf.io/hcmkp/), I asked if even arbitrary ritual can influence the ERN, and if so in which direction (amplified or muted ERN). Do rituals regulate goal-directed performance by (i) improving regulatory control through enhanced error/failure detection, or (ii) dulling the threat of personal failure? For support of (i), I would expect that rituals would lead to heightened performance-monitoring, as shown by an amplified ERN. For support of (ii) I would expect that rituals would lead to a reduction in performance-monitoring, as shown by a muted ERN.

2 Study 6 Methods

2.1 Participants and Power Analysis

A power analysis using *G*Power* (Faul, Erdfelder, Lang, & Buchner, 2007) was run to determine sample size. Using a mixed, pre-post design and assuming the typical moderate effect size in social psychology (i.e., r = .21, d = .43; Richard, Bond, & Stokes-Zoota, 2001) and high correlations between repeated measures typical of ERP designs (r = .60 - .80; Olvet & Hajcak, 2009_a; Segalowitz, Santesso, Murphy, Homan, Chantziantoniou, & Khan, 2010), I determined that a total sample size of 48 participants yields a power value of 0.90 for detecting the hypothesized within-between interaction. I therefore decided to stop data collection between 50-60 participants to account for participant exclusions.

Fifty-nine participants were recruited from the University of Toronto Scarborough Campus through introductory psychology courses and campus advertisements. Eleven participants were excluded from all analyses due to equipment/hardware malfunction (n = 3), high EEG artifact rate (>30%; n = 5), failure to understand task instructions (n = 1), and the commission of too few errors to calculate reliable evoked potentials (n = 2). ERN calculations were based on no fewer than five artifact-free error trials (Olvet & Hajcak, 2009). Half of one participant's data was excluded because they made too few errors in the second block of the in-lab experiment (fewer than five). Their usable data was still entered into the mixed effects

models using MLM (more below; see Gueorguieva & Krystal, 2004). To ensure compliance, during funnel debriefing I confirmed that participants in the ritual condition completed the actions at home no less than twice ($M_{total\ compliance}$ = 6.78 times)[iii]. This left us with a final sample 48 participants (35 females; *mean age* = 19, *SD* = 1.48). Across conditions (ritual condition *n* = 22, control condition *n* = 26), participants were told that they could earn bonus money based on how well they completed the task ($10 guaranteed, with a chance to earn a bonus $10). However, regardless of how they performed, all participants received $15 for participating (as well as a course credit for those in introductory psychology courses). This deception (in regards to monetary compensation) was used to ensure that participants were motivated to perform at their best during the performance tasks.

2.2 Procedure

The experiment was comprised of an at-home and in-lab portion, lasting seven days in total. Participants were randomly assigned to a ritual or control (non-ritual movement) condition. They were told that the purpose of the study was to examine the mind-body connection and the effects of physical movement on cognitive performance. Importantly, the purpose of the study was kept vague in order to hold it constant across the two conditions and to control for study demand characteristics.

In the ritual condition, participants were asked to learn and memorize a set of elaborate ad-hoc action sequences (see Table 4 for specific steps of the ritualized actions). The operationalization of ritual consisted of these novel and arbitrary actions, which were meant to mirror the features of real-life rituals. These features included repeated and sequenced movements accompanied by a set of instructions that were prescriptive and rule-bound (for similar manipulations, see Norton & Gino, 2013; Hobson et al., in press). Importantly, the term ritual was never mentioned to participants, instead merely referring to the behaviors as action sequences; this was done to control for any prior beliefs participants may have had about rituals and the expectations of what rituals do to assist performance. Participants were provided with written instructions of the sequenced steps as well as a video model (https://osf.io/u2t75/) to help them follow along and commit the actions to memory.

*Table 4***.** The specific actions that were given to participants during the at-home portion of the study. The behaviors were precisely ritual-like with features mirrored real life rituals, including an emphasis on fixed episodic sequences and repetitive movements.

Action sequences instructions

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1. Place your hands flat on the table. Spread your fingers of your left hand and keep your fingers of your right hand together. Close your eyes, and take three slow deep breaths.

2. Now switch: spread your fingers of your right hand and bring your fingers of your left hand together. Close your eyes, and take three slow deep breaths.

3. Place the backs of your hands on the table, close your eyes, take three slow deep breaths.

4. Make fists and turn your fists over so the top of your wrist is facing upwards and your thumbs are inwards towards each other. Close your eyes, take three deep breaths.

5. Bring your fists together at your chest, slowly raise them above your head, and as you do draw in a large inhale through your nose. Return your fists to your chest while drawing out an exhale through your mouth. Repeat this three times.

6. Bring your open hands together at your chest (palm to palm), slowly raise them above your head, and then bring them back to your chest. Repeat this three times.

7. With your palms together at your chest, interlock your fingers so that your dominant hand's thumb is over the non-dominant thumb (i.e., dominant thumb touching your chest) and raise your hands above your head. Return them to your chest. Repeat this three times.

8. Starting at your chest, bring your interlocked fists to your right shoulder and hold for three seconds. Bring your interlocked fists back to your chest and hold for another three seconds. Bring your interlocked fists to your left shoulder and hold for another three seconds. Return your fists to your chest and clap twice.

9. Rest your hands, palms facing towards each other on the table in front of you. Hold for three seconds. Close your eyes and pull your hands apart. With your index/pointer fingers, tap the table ten times.

10. You are now finished.

In the control (non-ritual movement) condition, participants instead completed a coordinated movement task in which they were instructed to move their arms/hands at different times to touch moving block images on the computer screen. The amount of time and movement involved was the same as with the ritual actions. The only difference was that the control movements were not sequenced or repeated (i.e., strictly non-ritualistic). I was careful in this control manipulation so that I could infer that any observed differences would be attributable to the particular ritual movements themselves, and not any other non-ritual features of the at-home experience.

All participants were sent five email reminders, one per day, during the at-home portion and prompted to complete the questionnaire and tasks. On day 1 participants were recruited and introduced to the study and asked to complete a simple demographic questionnaire; on days 2-5 participants completed the main part of the at-home portion; on day 6, participants received feedback on their task performance over the past four days (more on this below); finally, on day 7 participants were scheduled for the in-lab portion of the study.

For the first four days, participants in the ritual condition were asked to complete the action sequences (following along with the model video for the first two days and then from memory for the remaining time), while participants in the control condition did the same randomized block touching task each day. Afterwards, all participants completed a short version of a Stroop task programmed using Inquisit 4.06. The Stroop task (Stroop, 1935) is a canonical inhibitory control task that reliably tracks executive function ability. It was used during the at-home portion in this case because I wanted participants to complete a reaction-time task that was similar to the task they would be completing in the lab, but still different in order to control for practice effects. Using a different (though related) executive function task allowed us to examine the ritual-performance link over the duration of the week-long experiment.

The Stroop task consisted of a series of colored words (red, green, blue, or yellow; congruent and incongruent trials) or colored blocks (control trials), in which participants were asked to identify the color in which each word was presented. Each trial consisted of a fixation cross (‘+’) presented for 500 ms, followed by the color word (block) presented for 200 ms, with a response window of 1000 ms. Participants completed 84 trials, split equally with 28 congruent trials, 28 incongruent trials, and 28 control trials. Last, participants responded to eight items on a

scale from 1 (strongly disagree) to 7 (strongly agree) asking how they felt about their performance on the Stroop. The questions read, "I felt [*item here*] about my performance." The items included: accomplished, confident, able to handle, mastery, anxious, calm, in control, and frustrated. For the purposes of the current investigation, I do not evaluate or discuss the results of the at-home task and questionnaires.

On the final day of the at-home portion, all participants were sent an email containing false performance feedback from the previous four days. The feedback consisted of a line graph showing participants reaction-times and error rates broken down by day, in comparison to the running overall average of the study. The plotted lines showed that participants had improved over the week and had been performing above average. In reality, every participant in both the ritual condition and control condition received identical feedback. This was done in order to convince participants that their performance was improving over time, further incentivizing their performance on the upcoming laboratory task.

After one week, participants came into the lab to complete the final portion of the study. When they arrived, participants were seated in front of a computer station and prepared for EEG recording. Continuous recording EEG was used while participants performed two rounds of a speeded inhibitory control task in a dimly lit room set at a viewing distance of approximately 100 cm to the screen. Different inhibitory control and speeded reaction tasks have been shown to elicit a reliable ERN signal. The performance paradigm used here was a modified go/no-go task, which consisted of a two-alternative, forced-choice task, where participants were instructed to press the /key with the right-hand if they saw an M ("go") target, and to press the Z key with their left-hand if they saw a W ("nogo") target. Key assignment was set on a standard QWERTY format and responses recorded using a millisecond sensitive DirectIN keyboard (Empirisoft, New York, NY). The M letter served as the frequent stimuli (.80 probability of appearing) and the W letter served as the infrequent stimuli (.20 probability of appearing). This imbalance in stimuli presentation was to ensure that participants developed a prepotent response tendency towards the frequent M ("go") stimuli, thus making the infrequent W ("nogo") stimuli error-prone, with successful button-press requiring inhibitory control. Because the task was forced-choice, both infrequent and frequent responses were recorded and analyzed. In the results

section, I refer to the frequent and infrequent stimuli as low-conflict and high-conflict trials, respectively.

Each trial commenced with a centered fixation cross (randomly presented between 150 – 300 ms), followed by the presentation of the target letter (200 ms) in white font on a black background and centered in the middle of the screen. The screen then remained blank until one of the response keys (/ or Z) was pressed or until the maximum response window (500 ms) was reached, in which participants were instructed to respond faster. The intertrial interval varied randomly between 450 and 1,000 ms before the start of the next trial. An incorrect response was immediately followed by an "error" message in white font on the black background and lasting for 500 ms before proceeding to the next trial.

To incentivize their performance, participants were given the following instructions: *"The faster and more accurate you are in your responding, the more bonus pay you will be given. Remember, peak cognitive performance = fast & accurate."* Participants first completed 20 practice trials where they were told their performance was not being monitored for the bonus pay. Following this, they completed a total of 760 experimental trials, which were divided into 8 blocks of 95 trials and separated by self-paced rest periods in between. I used a pre/post within subjects experimental design, in which all of the participants first completed the first 4 blocks (i.e., pre-rounds), followed by the movement manipulation done once more in the lab, and then again the final 4 blocks (i.e., post-rounds).

Before beginning the pre-rounds, participants answered four motivated preparation questions, which asked them to think about and anticipate their upcoming performance (e.g., "How mentally prepared do you feel heading into the task?" and" How well do you expect to perform on this round?") on a 1 ("not prepared at all"; "not well at all") to 7 ("very prepared"; "very well") scale. The four motivated preparation items were combined into an aggregate score and used in subsequent analyses (*Cronbach's* α = .87). After answering these questions, participants completed 4 blocks of the pre-round trials.

After the pre-rounds, participants were asked to report their subjective experience of how they felt during their performance using the same eight items from the at-home portion. Three questions asked about participants' specific emotional experience (anxious, calm, and frustrated), while the remaining five questions asked about their efficacy appraisals (control, accomplished,

confident, handle, and mastery). Anxiety and frustration were reverse-scored and combined with calm to create an aggregate positive affect score (*Cronbach's α* = .86). Similarly, control, accomplished, confident, handle, and mastery were combined to create an aggregate score for self-reported efficacy (*Cronbach's α* = .94).

The actions manipulation was carried out in between the pre- and post-rounds. Participants in the ritual condition were asked to complete the action sequences as they had memorized them over the course of the week, and to press the spacebar key once finished. Participants in the control condition completed the block touching task for the same amount of time. Afterwards, all participants completed the four motivated preparation questions like before. Participants then finished the final 4 blocks of the post-round trials, and again answered the same emotion and efficacy questions.

At the end of the performance task, participants in the ritual condition completed a set of questions that asked how they felt about their week-long experience in completing the action sequences. There were six items related to the ritual appraisal (ease, enjoyment, effort, special, meaningful, and powerful). I reverse scored effort and combined all the items (*Cronbach's α* = .78) to create an index for positive ritual appraisal. Finally, participants in the ritual condition were asked to report how they felt about the experience of learning the action sequences over the course of the week. I recorded their open-ended answers for qualitative purposes. All participants were then thanked and fully debriefed.

2.3 Neurophysiological Recording and Analysis

Continuous EEG was recorded during the eight blocks of the executive function task using a stretch Lycra cap embedded with 32 tin electrodes (Electro-Cap International, Eaton, OH). The scalp-electrode montage consisted of midline electrode sites (FPz, Fz, FCz, Cz, CPz, Pz, and Oz). Online recordings used the average of all electrodes and a forehead channels as reference and ground, respectively, and then were re-referenced offline to the average of the two ear electrodes. The continuous EEG data were digitized using a sample rate of 512 Hz, and electrode impedances were maintained below 10 kΩ during recording. EEG activity was amplified using an ANT Refa8 TMSi device (Advanced Neuro Technology, Enschede, The Netherlands). Offline, both sets of signals were referenced analyzed with Brain Vision Analyzer 2.0 (Brain Products GmbH, Munich, Germany).

The EEG data was digitally filtered offline between 0.1 and 15 Hz and the data corrected for vertical electro-oculogram artifacts (Gratton, Coles, & Donchin, 1983). An automatic procedure was employed to detect and reject artifacts. The criteria applied were a voltage step of more than 25 μV between sample points, a voltage difference of 150 μV within 150 ms intervals, voltages above 85 μV and below -85 μV, and a maximum voltage difference of less than 0.50 μV within 100 ms intervals. These intervals were rejected from individual channels in each trial in order to maximize data retention.

Using previous protocol for analyzing the ERN (e.g., Saunders, Rodrigo, & Inzlicht, 2015), the continuous EEG was segmented into epochs that commenced 200 ms before the response and lasted for 800 ms post-response. The ERPs (both the correct-related negativity; CRN, and ERN) were averaged separately for each experimental condition (ritual versus control). The CRN and ERN were operationalized as the mean amplitude between 0 and 80 ms at electrode FCz (e.g., Wiswede, Münte, & Rüsseler, 2009). A 0 – 80 ms time window was chosen to define the ERN because the component peaked somewhat earlier, at around 50 ms, compared to similar studies from our lab and others, in which the peak typically happens later around 70 ms. The results were no different when alternative time windows were used, including 0 to 100 ms. ERN calculations were based on no fewer than five artifact-free error trials (Olvet & Hajcak, 2009). Finally, EEG data were baseline corrected between -150 to -50 ms pre-response.

2.4 Statistical Analyses

All the analyses were conducted using multilevel modeling (MLM) with the MIXED function in SPSS (v. 22.0). A 2-level multilevel model was used to account for within-subjects performance and ERN nested within individual participants while estimating a random intercept for each participant. I included all possible main effects and interactions in each model tested. I used an unstructured covariance matrix and the between-within method for estimating degrees of freedom. Effect sizes were estimated with *semi-partial* R^2, (R^2_β; Edwards, et al., 2008).

For the behavioral data (mean RTs and choice error rates), the effect of condition (1 = ritual, -1 = control) was modeled as a function of round (1 = pre, -1 = post) and conflict level (1 = high conflict, -1 = low conflict). For the ERP analyses, the initial model was identical to the behavioral data, except conflict level was replaced by trial type. Here, trial type accounted for the correct-related negativity (CRN) and error-related negativity (ERN) ERPs (1 = CRN, -1 = ERN).

3 Study 6 Results

3.1 Performance: choice error rates and mean RTs

All data are open and available on the Open Science preregistration site (osf.io/h64cz). I report all measures, manipulations, and exclusions. Confirming the task's conflict manipulation, the model indicated a large main effect of conflict, with participants generating higher error rates on high-conflict trials (M = 20.16%, SE = 1.13) than low-conflict trials (M = 0.72%, SE = 1.13), b = -17.28, t(138) = -7.04, SE = 2.46, p < .0001, 95% CIs [-22.14, -12.43], R^2_β = .66. There was also a small, albeit non-significant effect of round, b = 4.13, t(138) = 1.68, p = .095, SE = 2.46, 95% CIs [-0.73, 8.98], R^2_β = .01, such that participants tended to have lower error rates in the pre rounds (M = 9.56%, SE = 1.13) than the post rounds (M = 11.29%, SE = 1.13). These analyses confirm the high versus low conflict manipulation. There was no main effect of ritual, b = 0.30, t(138) = 0.11, p = .92, 95% CIs [-5.25, 5.85], R^2_β = 0.001, nor was there a significant two-way interaction between ritual condition and round, b = -0.69, t(138) = -0.21, p =.84, 95% CIs [-7.28, 5.91], R^2_β = 0.001. Together, these results suggest that the ritual manipulation had no effect on error-rates.

Next, the same model was run with mean RTs. Again, the model indicated a large main effect of conflict, with participants responding more slowly during high-conflict trials (M = 414.44 ms, SE = 7.42) than during low-conflict trials (M = 346.09 ms, SE = 7.42), b = -65.48, t(138) = -9.33, SE = 7.02, p < .0001, 95% CIs [-79.36, -51.60], R^2_β = .75. There was no effect of ritual condition, b = 1.33, t(138) = 0.09, p = .93, 95% CIs [-29.81, 32.47], R^2_β = 0.001, nor of round, b = -1.86, t(138) = -0.27, p = .79, 95% CIs [-15.75, 12.02], R^2_β = 0.00, and no two-way interaction between ritual condition and round, b = -5.06, t(138) = -0.53, p = .60, 95% CIs [-23.92, 13.80], R^2_β = 0.001.

Table 5 contains all the descriptive data for behavioral, self-report, and EEG measures. Theses analyses show that all participants were faster and more accurate in the low-conflict trials. However, there were no differences in performance between ritual and control conditions, suggesting that the ritual had no impact on behavioral performance.

Table 5. Means (SD) for self-reported subjective experience, performance on the inhibitory control task, and electroencephalography (EEG) measures. Means across rows (within each condition) with different subscripts differ significantly at $p < .05$ (two tailed).

	Control condition		Ritual condition	
Dependent variable	Pre-rounds	Post-rounds	Pre-rounds	Post-rounds
Self-report appraisals				
Positive emotion	4.76_a (1.34)	4.76_a (1.45)	4.86_a (1.24)	4.73_a (1.48)
Efficacy	4.27_a (1.30)	4.47_a (1.42)	4.65_a (1.27)	4.68_a (1.02)
Motivated preparation	4.90_a (0.84)	4.70_a (0.97)	5.08_a (1.01)	5.13_a (1.03)
Positive ritual appraisal	-		5.33 (0.99)	
Performance				
Low-conflict error rate	1.0_a (0.94)	0.58_b (0.65)	0.84_a (1.12)	0.46_b (0.78)
High-conflict error rate	18.42_a (12.17)	21.86_b (14.58)	18.12_a (12.83)	22.25_a (15.06)
Low-conflict RT	352.96_a (52.22)	343.54_b (55.60)	350.50_a (37.81)	337.35_b (32.91)
High-conflict RT	417.31_a (58.69)	410.38_a (66.67)	415.98_a (54.46)	414.11_a (59.52)
Electroencephalography				
ERN (μV)	-2.26_a (6.07)	-2.23_a (5.97)	-4.87_a (7.97)	-1.22_b (6.09)
CRN (μV)	4.27_a (5.61)	3.73_a (5.46)	5.21_a (5.58)	3.81_b (5.44)
ΔERN (ERN-CRN)	-6.54_a (7.55)	-6.05_a (5.09)	-10.08_a (7.55)	-5.07_b (5.20)

3.2 ERN Data

I next tested our main hypothesis to examine whether arbitrary ritual impacts the ERN either by increasing performance-monitoring or decreasing performance-monitoring. To do this, the effect of condition on the error-related ERPs (ERN and CRN) was examined. The ERP data (i.e., the ERN and CRN while including the factor of trial type in the model; see above) was considered. The model output revealed evidence of a reliable ERN as indicated by a more negative ERP amplitude in response to erroneous (M = -2.65 μV, SE = 0.86) than correct (M = 4.26 μV, SE = 0.78) responses, b = 10.08, $t(46) = 6.27$, SE = 1.61, $p < .0001$, 95% CIs [6.84, 13.31], $R^2_\beta = .63$. This was qualified by a significant two-way interaction between round and trial type, b = -5.05, $t(46) = -3.27$, SE = 1.55, $p = .002$, 95% CIs [-8.16, -1.94], $R^2_\beta = .14$, indicating that the difference between ERN and CRN amplitudes was lessened in the post rounds (M_{ERN} = -1.73 μV, M_{CRN} = 3.77 μV) compared to the pre rounds (M_{ERN} = -3.57 μV, M_{CRN} = 4.74 μV), an effect consistent with past work on the neural correlates of fatigue (Boksem, Meijman, & Lorist, 2006; Inzlicht & Gutsell, 2007).

Critically, this two-way interaction was subsumed under a three-way interaction, where the interaction between round and trial type was moderated by our manipulation of ritual condition, b = 4.48, $t(46) = 2.14$, SE = 2.09, $p = .037$, 95% CIs [0.27, 8.69], $R^2_\beta = .09$. While significant by the standards of null-hypothesis significance testing, I note that I have only modest support for this hypothesized (and pre-registered) effect. Figure 6 displays the ERP and topographical graphs[iv]. These show a relatively large reduction in the post rounds compared to the pre rounds for participants in the ritual condition. It appears, therefore, that a dampened ERN in the ritual condition offers preliminary support for the hypothesis that ritual decreases performance-monitoring.

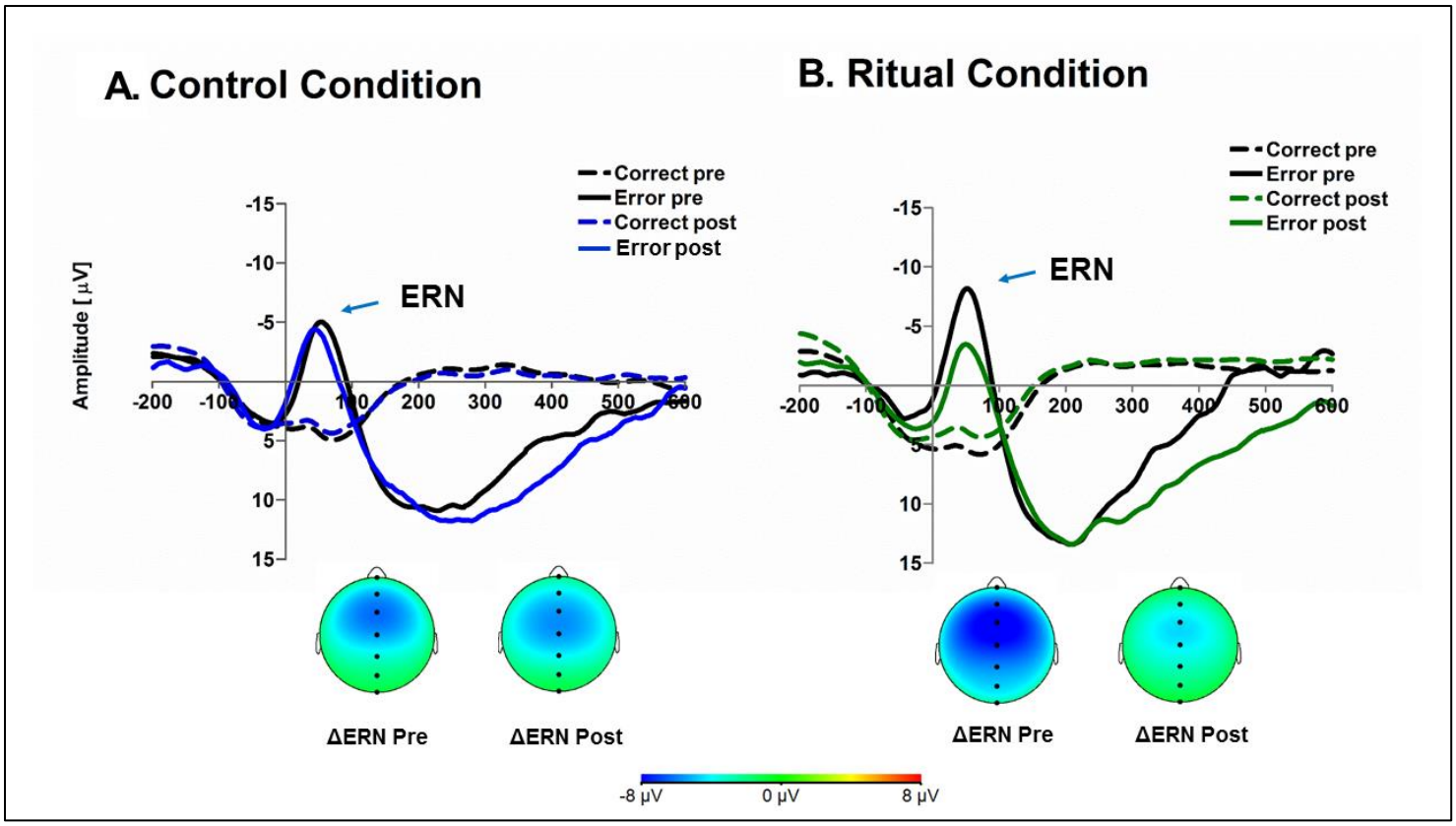
These analyses were followed up with a series of simple effects tests. First looking at participants in the ritual condition, the model revealed that during error trials, the ERN amplitude was significantly reduced (i.e., less negative) in the post rounds (M = -1.22 μV, SE = 1.30) compared to pre rounds (M = -4.87 μV, SE = 1.70), $t(46.83) = 2.24$, $p = .03$. Moreover, opposite to the this pattern, it was found that during correct trials, the CRN amplitude was significantly larger in the post rounds (M = 3.81 μV, SE = 1.16) compared to the pre rounds (M = 5.21 μV, SE

= 1.19), $t(45.30) = 2.95$, $p = .005$. The same comparisons done with participants in the control condition showed that the ERN amplitudes were no different in the pre rounds (M = -2.26, SE = 1.56) compared to the post rounds (M = -2.23, SE = 1.17), $t(45.79) = 0.02$, $p = .98$. The CRN amplitudes were also no different during pre (M = 4.28, SE = 1.10) and post rounds (M = 3.73, SE = 1.07), $t(45.05) = 1.26$, $p = .21$. The simple effects comparing ERNs/CRNs within pre and post rounds revealed no differences between ritual and control conditions. CRNs for both conditions were no different for both pre rounds ($t(46) = 0.58$, $p = .57$) and post rounds ($t(46) = 0.04$, $p = .97$). There was also no differences in ERNs for both conditions in pre rounds ($t(46) = 1.13$, $p = .26$) and post rounds ($t(45.86) = 0.58$, $p = .57$).

An indirect effects model (Preacher & Hayes, 2008) was run to test whether the pre/post ritual manipulation was tied to performance through the effect of a dampened ERN amplitude. Research typically indicates that a lower ERN relates to poor performance (e.g., Hobson et al., 2014), but this was not the case here. Looking at the ritual conditions separately, a dampened ERN was generally associated with worse performance, as revealed in higher error-rates, but only in the control condition (pre round: $r(26) = .34$, $p = .09$; post round: $r(26) = .47$, $p = .015$). This link did not hold for participants in the ritual condition (pre round: $r(22) = .15$, $p = .51$; post round: $r(21) = .24$, $p = .29$). These results suggest that the effect of a muted ERN after completing the ritual was somewhat independent of task performance. Though this is not directly tested here, it is possible that the ritual in this case facilitated performance by impacting the emotional component of the action-monitoring system (dulling the neuroaffective response to errors) without sacrificing features of conflict-monitoring and cognitive performance. However, more work is needed to directly test this hypothesis.

Altogether, the evidence from the above analyses offers modest support for the hypothesis that arbitrary, ad-hoc ritual (despite not being called ritual) reduces performance-monitoring, muting the neuroaffective response to distressing performance failures during task performance.

Figure 6. Error-related ERPs as a function of condition assignment (left panel = control condition; right panel = ritual condition), trial type (correct = dotted lines; errors = solid lines) and manipulation time-point (pre-rounds = black lines; post-round = colored lines).
Spline head maps: Scalp distributions of the ΔERN (difference wave = ERN-CRN) for mean activity (0 – 80 ms) as a function of condition assignment and time-point.



4 Study 6 Discussion

With a multiday experimental design using arbitrary and novel ritual-like actions, I offer causal evidence that performance rituals impact the neural regulatory system. Specifically, I find arbitrary ritual mutes the brain-based system attuned to the neuroaffective experience of regulatory failure. Despite decreases in performance-monitoring, however, the reduced ERN did not predict worse performance as it did in the control condition, a dissociation suggesting that ritual may be capable of regulating performance distress without sacrificing controlled behavior.

The fact that I do not see performance deficits linked to a reduced ERN might mean that ritual is capable of modulating performance-monitoring to ensure that an appropriate amount of error-related distress is still felt (but not too much). In other words, a ritual could help a person during performance find the anxiety sweet-spot that appears ideal for generating effective control (Yerkes & Dodson, 1908).

A limitation of the current experiment relates to how the physical features of the arbitrary ritual could have led to the observed effects. As demonstrated in Studies 4 and 5, the physical style of ritual is capable of regulating the emotive features of an anticipated psychological state. The physical features that I used to create the arbitrary ritual had a meditative and calming feel to them. The ritual actions also contained frequent interval breathing. If the actions were faster and more action-oriented, like the pre-performance ritual of a pumped-up athlete or musician, then it is possible that I would have seen the opposite pattern of effects with heightened performance-monitoring.

Taken together, the current experiment offers causal evidence of the psychological and neural basis of arbitrary ritual actions and their associated regulatory function. Though rituals might appear on the surface to be wasteful for expended energy and time, the presence of rituals in different performance contexts suggests they are critical to self-regulation and goal attainment. Here I offer preliminary support for the hypothesis that even an arbitrary ritual acts as a palliative by dulling the neural response to performance failure.

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Chapter 6
Ritualized Movement and Anxiety Reduction

1 Study 7 Introduction

Rituals act as an emotional buffer against anxiety and uncertainty. Multiple bodies of literature provide support for this hypothesis. Ritualized behaviors seem to emerge under circumstances characterized by high anxiety, uncertainty, and stress (Celsi, 1993; Keinan, 1994; Padgett & Jorgenson, 1982). Perhaps the earliest description of the link between anxious uncertainty and rituals is Bronislaw Malinowski's (1954) observation of fishing behaviors among the Trobriand Islanders in Melanesia in the early 1900s. Malinowski noticed that the islanders performed elaborate magical rituals when traveling in unpredictable and dangerous ocean waters but not when they were fishing in the safe waters of the lagoon, and concluded that the islanders used rituals in an effort to exercise some control over the otherwise uncertain conditions of open-sea fishing.

Clinical studies provide support for these observations. People with clinical disorders associated with anxiety, stress, or trauma often develop their own rituals, presumably as a coping mechanism to regain a sense of personal control (e.g., Rachman & Hodgson, 1980). Obsessive-compulsive disorder (OCD) in particular seems to be characterized by frequently engaging in ritual behaviors to ward off anxious and intrusive thoughts (e.g., Mataix-Cols, Rosario-Campos, & Leckman, 2005; Reuven-Magril, Dar, & Liberman, 2008). Other populations under intense stress such as abuse victims (Jacobs, 1989) and palliative care patients (Romanoff & Thompson, 2006) often adopt rituals as well.

Ritual as an anxiolytic is also frequently demonstrated in religious domains. Interestingly, researchers have noted morphological similarities between OCD rituals and religious rituals (Dulaney & Fiske, 1994; Fiske & Haslam, 1997). Freud was one of the first to note that, "it is easy to see the resemblance between the neurotic ceremonials of obsessions and compulsions and the sacred acts of religious ritual" (1924). Similar to ritualistic compulsions, religious rituals are known to be activated during times of anxiety and negative emotion (Ahler & Tamney, 1964; Anastasi & Newberg, 2008).

How can we explain these anxiolytic properties of ritual? The proposed framework suggests that completing the physical movements of a ritual directs a person's attention to the segmented actions that are involved. Honing one's attention to the sensory and motoric experience of the ritual directs attention away from negative emotion states. In line with this thinking, Boyer and Liénard (2007) propose that the low-level action units of ritual lead to a swamping of working memory that temporarily reduces anxiety. Specifically, the segmentation of *repeated* action units during ritual seems to be especially important for this process. A recent experiment (Lang, Krátký, Shaver, Jerotijević, & Xygalatas, 2016) manipulated anxiety by asking participants to engage in an evaluative public speaking task and comparing them to a low-arousal group. After the task, researchers used motion-capture technology to quantify various characteristics of hand movements. They found that anxiety measured at the physiological level led to an increase in repetitiveness and rigidity, and self-reported anxiety predicted redundancy of movement, all of which are characteristic of ritual behavior.

Reversing the causal direction, here in the current study I examined the impact of repetition on emotion arousal. Building off of the work by Lang and colleagues, I sought to test whether subtle manipulations in actual repetitive behavior leads to differences in affective judgment, and thus, to support the prediction that paying attention to ritual's parsed, repetitive actions minimizes anxiety by blocking out negative stimuli.

1.1 Hypotheses

I predicted that people who enact simple repetitive sequences while exposed to an emotional stimuli will report reduced arousal compared to when they enact non-repetitive sequences and also to when they engage in no movements at all. I expect to see people's arousal the highest when they view emotional stimuli without moving at all; by engaging in any type of movement, repetitive or non-repetitive, I should notice a general arousal reduction. But if repetitive action in particular plays a unique role in the relationship between ritual and emotion, then I should see this arousal dampening effect pronounced during moments of repetition.

2 Study 7 Methods

2.1 Participants and Power Analysis

A power analysis using *G*Power* (Faul et al., 2007) was done to determine a stopping rule and final sample size. I considered the within-subjects design and assumed the standard moderate effect size in social psychology (i.e., r = .21, d = .43; Richard et al., 2001), in addition to a small-to-moderate correlation measure between the repeated measures (r = .40) as a conservative estimate. From this, I determined that a total sample size of 51 participants yields a power value of 0.95 for detecting omnibus one-way effects within our predicted model. I therefore decided to stop data collection around the 50 participant mark.

Fifty-two participants were recruited from the University of Toronto Scarborough Campus through introductory psychology courses and campus advertisements. Two participants were excluded from all analyses due to missing data from a software glitch in the programmed task (n = 1) and failure to comply with the response instructions leading to unusable data (n = 2). This left us with a final sample of 50 participants (36 females; *mean age* = 19.86, *SD* = 4.76).

2.2 Procedure

Participants arrived to the lab and were told that the purpose of the study was to measure the connection between emotion, bodily sensation, and physical movement. They were told they would be connected to a physiological sensorimotor system that monitored and detected body movements/touches. In reality, the sensors and wires were part of a fake apparatus created for the study. The apparatus acted as a cover story to convince participants that I was measuring their idiosyncratic movements and that I was interested in how this related to different emotions states. The bogus sensors allowed me to selectively manipulate when and how participants carried out specific movements, either repeated or non-repeated, and to ultimately test the hypothesis in a controlled and unobtrusive manner.

2.2.1 False Physiological Recording

The apparatus consisted of two lengths of running wire (left and right), each fed through three Velcro straps for both the left hand/arm and right hand/arm (six straps in total): A lower wrist strap (x2), a middle elbow strap (x2), and a higher shoulder strap (x2). Ten fake sensors

were placed along the two lengths of running wire, five on each side. Each of the straps had a disc sensor embedded in the Velcro material that made contact with the skin of the participants. Two additional sensors attached to the running wire were taped to the skin, placed on the back of the hands and on either side of the neck. Together, the ten sensor placements included: left/right hand, left/right wrist, left/right elbow, left/right shoulder, and left/right neck.

The two lengths of wire joined together at the base of the head on the back of the neck and taped together after the sensors were attached to participants. Finally, a separate wire was taped to the back of the computer tower underneath the participants' desk. The other end of this connector wire was joined at the back of the neck where the arm wires were taped together. Participants were led to believe this wire connected the sensors and straps to the physiological computer/recorder where their movements would be monitored and recorded. To enhance the believability of the apparatus and cover story, I used real psychophysiological equipment made up of Ag-AgCl electrode sensors, wires, conductance gel, and electrode tape from MindWare (MindWare Technologies, Gahanna, OH).

After the cover story was explained to the participants, they were fitted with the straps and sensors. The Velcro material was fashioned so that it could move along the length of wire with adjustable band sizes, which ensured a proper fit for each participant. The experimenter made sure each of the sensors were taped properly into place and then joined the connector wire to the participants' back of the neck.

The experimenter told participants there would be a quick test before proceeding to make sure the recording equipment and sensors were working properly. This served as another element of the cover story to help minimize suspicion of the fake equipment and setup. The test was a 20 second-long video of actual physiological recording activity, which included voltage activation lines running across the screen. At two time points in the video – the 5 second and 10 second mark – the activation lines showed a sudden movement, and then returned to the flat baseline level, suggesting a change in the physio-recording. The experimenter, knowing exactly when these two time points occurred in the video, asked participants to move their arm just before the change. To the participants watching on screen, their arm movement coincided with a sudden change in the activation lines.[v]

2.2.2 Phase 1: Repetition Priming

The first phase included a novel repetition priming procedure in which participants were required to move their arms and hands while touching the different sensor locations. Here, the goal was to have participants engage in one specific repetitive sequence without giving them explicit instructions to do so. Participants were given headphones and listened to audio instructions that called out the sensor location to touch (ex. “left wrist, right shoulder, etc.”). The audio instructions were chunked into 5-step sequences that included five separate sensor location calls. There were fifty sequences called out in total (250 total sensor touches), half of which were non-repeated and the other half repeated.

First, the non-repeated sequences stimuli were programmed beforehand using a random number generator, with each of the ten sensor locations assigned a number value in excel. The randomizer ensured that none of the twenty-five sequences were doubled across the exposure. Second, the repeated sequence was made up of the same 5-step sensor touching sequence, specifically: “left hand, left wrist, right wrist, left shoulder, left neck*.”* All twenty-five of the repeated calls followed this same sequenced order. The calls within a sequence were spaced out at 2.5 sec to make it easy for participants to follow along, while the calls between the sequences were spaced out longer, at a 5 sec pause. The longer pause between sequences was programmed to prevent the repetition sequence from blending with the sequence that preceded and the sequence that followed. In sum, the subtle repetition manipulation provided a test of the hypothesis by first getting participants used to the repetitive movements.

However, participants were led to believe that this first part was meant to orient the physiological system to their own personal style of movements and that this would help create a personal “profile” used later on. They were told:

> *Previous work has shown that physical movement is closely tied to our psychological state. In this study, you will be helping us explore these connections further. The sensors attached to you right now measure and record, each time you move, the sensorimotor activity of a particular body area (i.e., hands, wrists, arms, head, etc.). The collection of all your movements will be compiled at the end of the experiment and provide us with a personalized profile.*

To start we'll first get you to do various movements/touches. In order to get the most accurate measurements and recording from the physiological system for the next part of the study, we need to do a series of sensorimotor tests. You'll hear a series of sequences called out, and your job is to simply touch the correct sensor. There will be multiple blocks of instructions, anywhere from 7-10 depending on how long it takes the system to adjust.

2.2.3 Phase 2: Movement and Affect Responses

After the repetition priming phase finished, participants were told the main part of the study would start. Participants watched a series of video clips while listening to similar audio instructions from the first part. In a 3 X 3 repeated measures design, I manipulated (i) video content (pleasant vs. unpleasant vs. neutral) and (ii) action style (repetition vs. non-repetition vs. passive viewing). Participants watched a total of twenty-one video clips (each one 40 sec in length), including nine pleasant, nine unpleasant, and nine neutral videos. Examples of pleasant videos included penguins playing and diving off an iceberg and a puppy running around; examples of the unpleasant videos included an open-heart surgery and a patient with a large facial tumour; and examples of the neutral videos included a panning city view and an automated photocopier printing paper. See Appendix D for a short written description of all videos.

For the movements, participants listened to audio instructions that called out sensor locations like before. However, the instructions varied randomly across the presentation of the videos so that each video was paired specifically with one of the following: (i) repeated instructions, (ii) non-repeated instructions, or (iii) no-instructions (for the passive viewing). The repetition instructions consisted of the same repeated 5-step actions from the initial phase, repeated three times during a single video – "left hand, left wrist, right wrist, left shoulder, left neck." The non-repetition instructions consisted of novel, non-repeated actions with three different sequences during a single video. For both the repetition and non-repetition trials, the instructions were called out three times at 0 sec, 15 sec, and 30 sec during a single video presentation. For the passive viewing condition, participants were simply asked at the beginning of the video to watch without touching any sensors. The pairing of videos with action styles and

the order of video presentation was counterbalanced and randomized to ensure that each action style was paired with nine video clips, exactly three clips for each of the three content types.

The breakdown was as follows: Participants listened to (i) repetition instructions (repeated trials) for three pleasant videos, three unpleasant videos, and three neutral videos; (ii) non-repetition instructions (non-repeated trials) for three pleasant videos, three unpleasant videos, and three neutral videos; and (iii) no instructions (passive viewing) for three pleasant videos, three unpleasant videos, and three neutral videos. With this design, I was able to see whether people's emotional responding to the videos changed as a function of carrying out repeated movements (versus non-repeated movements or no movements at all).

To measure changes in affect, after each video finished, participants were asked, *"*How did you feel during the video?" Participants indicated their response using the Self-Assessment Manikin (SAM) pictorial scale. SAM is a validated and reliable affect measure used to assess emotion in response to an item, object, or situation (Bradley & Lang, 1994; Lang, 1980). The scale measures the three major affective dimensions – pleasure, arousal, and dominance (Hodes, Cook, & Lang, 1980; Russell, 1980). Here, the pleasure dimension ranged from a smiling, happy figure to a frowning, unhappy figure; the arousal dimension ranged from an excited, alert figure to a calm, sleepy figure; and the dominance dimension ranged from a small, submissive figure to a large, controlling figure. Each of the dimensions included nine pictures of the dynamically changing SAM figures; participants were asked to indicate their three response (one for each dimension) by clicking on the appropriate figure boxes. The responses were coded into a numerical value ranging from 1-9 with these numbers used in subsequent analyses.

3 Study 7 Results

Three separate 3 (video content: unpleasant vs. pleasant vs. neutral) X 3 (action style: repetition vs. non-repetition vs. passive-viewing) repeated-measures ANOVAs were done for each affect dimension.

First looking at arousal ratings, there was a large main effect of video content $F(2, 48) = 75.41$, $p < .00001$, $\eta^2 = 0.76$, indicating a difference in felt arousal for the three different styles of video, collapsed across action style. Pairwise comparisons revealed that participants' arousal ratings during unpleasant videos ($M_{\text{unpleasant}} = 4.98$, $SD_{\text{unpleasant}} = 1.70$) differed from arousal

ratings during pleasant videos ($M_{pleasant}$ = 4.39, $SD_{pleasant}$ = 1.43), $t(48) = 2.56$, $p = .01$, and neutral videos ($M_{neutral}$ = 2.70, $SD_{neutral}$ = 1.17), $t(48) = 9.05$, $p < .00001$. The last two were also different from each other $t(48) = 11.50$, $p < .00001$. See Figure 7a for individual means across all video types.

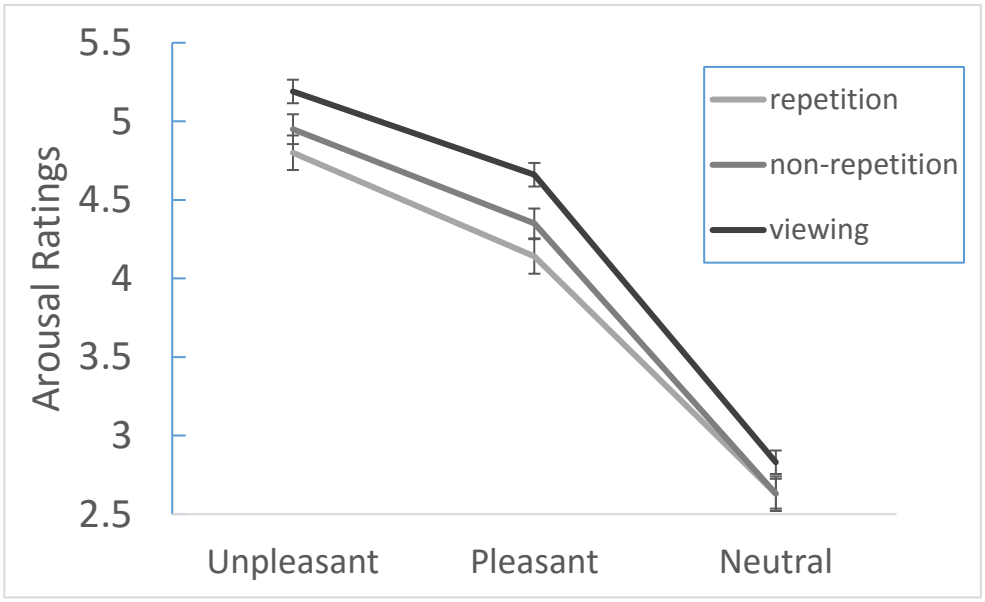
In line with my hypotheses, the model also revealed a main effect of action style, $F(2, 48) = 3.94$, $p = .026$, $\eta^2 = 0.14$, indicating a difference in arousal across the three types of repetition/movement instruction, collapsed across video types. There was no significant interaction between video content and action style, $F(4, 46) = 0.30$, $p = .88$, $\eta^2 = 0.025$. I conducted a series of follow-up contrasts comparing the action styles combined across video content. See Figure 7b for means collapsed across video. First, using Helmert coding, comparing the mean of repetition instructions to the combined mean of non-repetition/passive viewing instructions (Level 1 vs. Levels 2/3), I saw once again a significant effect, $F(1, 49) = 6.10$, $p = .017$, $\eta^2 = 0.11$, showing that participants reported less arousal when videos were watched during the repetitive actions ($M_{repetition}$ = 3.86, $SD_{repetition}$ = 1.27) compared to when the videos were watched during non-repetitive actions and passive viewing ($M_{non\text{-}repetition/passive\text{-}viewing}$ = 4.16, $SD_{non\text{-}repetition/passive\text{-}viewing}$ = 1.26). These results were also followed by a clear linear trend between the three action style instructions, $F(1, 49) = 8.04$, $p = .007$, $\eta^2 = .14$. Next I looked at the individual pairwise comparisons. Though participants felt less arousal during the repetition instructions compared to the passive-viewing instructions, $t(48) = 2.84$, $p = .007$, there was no difference in their reported arousal between repetition and non-repetition instructions, $t(48) = 1.10$, $p = .28$.

Next looking at valence ratings, there was a large main effect of video content, $F(2, 48) = 109.66$, $p < .00001$, $\eta^2 = 0.82$, as expected with participants feeling most positive during pleasant videos ($M_{pleasant}$ = 6.40, $SD_{pleasant}$ = 1.21), most negative during unpleasant videos ($M_{unpleasant}$ = 2.91, $SD_{unpleasant}$ = 1.03), $t(48) = 14.48$, $p < .00001$, and in between during neutral videos ($M_{neutral}$ = 4.98, $SD_{neutral}$ = 1.17), $t(48) = 9.61$, $p < .00001$. There was no main effect of action style, $F(2, 48) = 0.34$, $p = .71$, $\eta^2 = 0.01$, and no interaction between video content and action, $F(4, 46) = 0.86$, $p = .49$, $\eta^2 = 0.07$.

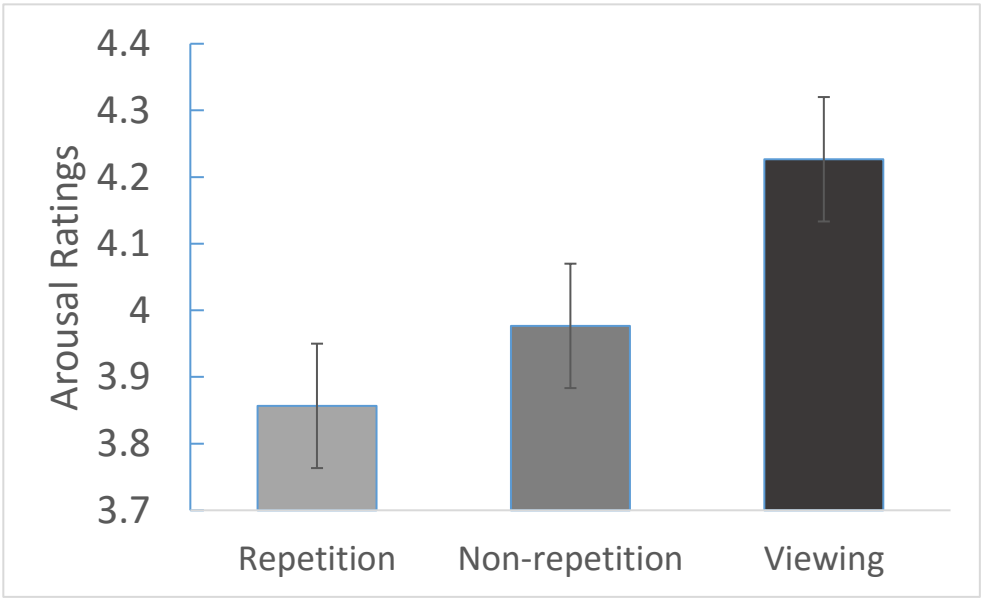
Last, looking at dominance ratings, there was again a main effect of video content, $F(2, 48) = 5.87$, $p = .005$, $\eta^2 = 0.20$. Participants reported feeling the least amount of control during the unpleasant videos ($M_{unpleasant} = 4.58$, $SD_{unpleasant} = 1.56$) relative to both pleasant videos ($M_{pleasant} = 5.41$, $SD_{pleasant} = 1.72$), $t(48) = 3.42$, $p = .001$, and neutral videos ($M_{neutral} = 5.31$, $SD_{neutral} = 2.06$), $t(48) = 2.55$, $p = .01$. There was no main effect of action style, $F(2, 48) = 0.45$, $p = .64$, $\eta^2 = 0.02$, and no interaction between video content and action, $F(4, 46) = 0.80$, $p = .53$, $\eta^2 = 0.07$.

Figure 7. Results of SAM arousal ratings in response to different video types as a function of condition – repetition vs. non-repetition vs. passive-viewing (A). Results of SAM arousal ratings combined across video types as a function of condition (B). Error bars represent standard error of the mean.

A.



B.



4 Study 7 Discussion

The findings from this experiment provide partial support for the prediction that engaging in ritualized action dulls emotional arousal in affective judgments. However, opposite to my hypothesis, the direct contrast indicated no difference between repeated and non-repeated movements on arousal ratings. This implies that the effect of reduced anxiety during ritual could be attributed to movement in general. Engaging in any movement during ritual, whether repeated or non-repeated, could serve as a distraction in directing one's attention away from negative emotional stimuli. Based on this distraction account, it is reasonable to think that the repeated sequence might have become more fluent over time, freeing up attention during the video watching. And opposite to this, to be able to follow along to the non-repeated sequences would have required the same amount of attention across the experiment. If this is the case, then the non-repeated actions should have acted as a better distraction.

The question of parsed actions in ritual either freeing up or limiting attention has been hinted at before by researchers (e.g., Boyer & Liénard, 2006). In certain contexts, rituals appear to hone attention to the ritual and surrounding environment (Vohs et al., 2013), while in other contexts, they appear to swamp executive attention and block out the surrounding environment (Schjoedt et al., 2013). The psychological framework I am proposing attempts to resolve this apparent contradiction by examining the exact type of psychological processing that might be at play in those different contexts.

As one example, the amount of processing required to enact a ritual will change across time as a person becomes more familiar with the actions. To a novice, a ritual will be less familiar and more complicated, demanding more of their attention in order to properly complete the actions. But over time, with regular practice, the novice becomes an expert: the automatization and overlearning of the sequences eventually leads to a state where less attention is required to successfully complete the ritual. In the context of ritual reducing anxiety, this transition would make such a ritual a less effective anxiolytic because it would eventually fail to block out the source of anxiety. As actions become more automated, perhaps the ritual requires updating. This explanation fits with the ritualistic compulsions symptomatic of OCD: The sequences involved in the compulsions become more elaborate and complex over time as the former rituals become "not enough" (Hyman & Pedrick, 2010).

Chapter 7
General Discussion

1 Summary

Using the novel theoretical framework proposed in the introduction, here I report findings from seven experiments specifying the psychological causes and effects of ritual. In the real-world, ritual's outcomes are impressively diverse, spanning different domains of human functioning and behavior. Indeed, it is because of this complexity and heterogeneity that ritual has captured the interest, and at times confusion, of researchers for over a century. Now, rather than seeing each ritual as different, we can begin to conceptualize all forms of ritual as possessing a common psychological basis. This theoretical position taken up in the beginning of the dissertation finds empirical support in a series of testable (and tested) hypotheses.

In Studies 1 and 2, I find evidence that collective rituals are responsible for regulating both ingroup and outgroup interactions. Costly signaling theory posits that extravagant rituals strengthen ingroup ties (Alcorta & Sosis, 2005; Atran & Norenzayan, 2004), but does not make specific predictions about outgroup interactions. These findings offer initial evidence that outgroup derogation may also play a role in producing the effects of ritual on intergroup bias. Future research is needed to explore how group rituals may differentially affect bias toward ingroups and against outgroups – especially when ingroups and outgroups perform competing rituals, as, for example, with members of different religious faiths who are similar but different (Brewer & Pickett, 1999), like the Protestants and Catholics in Northern Ireland.

In Study 3 I find that even small variations in sequence (mis)matching predict group functioning. This effect appears to be driven by people's appraisals of the ritual experience. When group members engage in matching sequence, they feel better about the situation and about the ritual itself. One interesting point to note here is that enacting even arbitrary ritual in novel groups is judged as more meaningful (with an average rating of just over the midpoint of the 7-point scale), an effect I have replicated in other studies as well.

This aligns with recent work showing that when observing a person interact with the physical world, non-instrumental (i.e., ritualistic) actions are perceived as more meaningful than instrumental actions (Kapitány & Nielsen, 2015, 2016). Why might ritual actions, even arbitrary

ones, be seen as more meaningful? The answer seems to be related to the nature and evolution of social learning. When it comes to cultural transmission, humans can adopt either the 'instrumental stance' or the 'ritual stance.' The instrumental stance happens when a person's behavior is causally relevant and involves knowable sequences of action-outcome goals that can be tweaked and made more effective (Claidière & Sperber, 2010); the ritual stance happens when a person's behavior is causally opaque and involves rigid ritual-like sequences that are done just-so for ostensibly important, though unknowable reasons (Legare & Herrmann, 2013; Herrmann, Legare, Harris, & Whitehouse, 2013). These reasons are a matter of signaling social convention, and the human mind has an evolutionary preparedness to attend to important social information as a matter of survival (Dennett, 1971; Gergely, Nádasdy, Csibra, & Biro, 1995; Rossano, 2012). The adaptationist approach would suggest then, that the enhanced meaning of ritual behaviors happens because paying attention to a social conventional rule would have conferred an evolutionary advantage. And thus, the meaning that a person feels is simply a positive response that reinforces a person to pay attention to such conventional, non-instrumental behaviors (i.e., ritual). This ultimate explanation generates its own testable predictions, which future research will be able to address.

In Studies 4 and 5 I find that the physical style and movement is a critical feature of ritual. This implies that rituals look differently, physically, across contexts because the actions themselves help regulate certain social, emotional, and goal states. The findings here suggest that the style of ritual done can lead to heightened group functioning and better team-based performance. The type of performance that is required will likely influence the look of the ritual. It is no coincidence, for example, that the New Zealand national rugby team's pregame ritual, the Haka War cry, involves movements that are fast, erratic, forward-leaning, and discordant. Such actions evoke an approach-motivated state, which presumably help boost performance in the ensuing game by appearing more threatening, angry, and competitive to the other team. However, consider that if the goal of a group is to engage with another outside group through peaceful resolution, a Haka-like ritual might not be best-suited for achieving the desired outcome.

The implication here is that not all styles of ritual will lead to positive group outcomes. Similar to the previous study, a ritual could end up backfiring and hinder group performance if

the ritual's style is not the appropriate one given the motivational or social context. An anecdote involving the famous Wal-Mart ritual offers one real-life example. The giant retail conglomerate attempted to enter the German market but was forced to exit shortly after, a failure owing to the clash in American versus German employee culture. Hundreds of surveyed employees reported that part of the reason had to do with the Wal-Mart preparation ritual: The actions involved were said to be far too regimented, oddly aggressive and mindless, reminiscent of the nation's political rallies of its shadowy past. An American ritual success, but a German ritual failure.

In Studies 6 and 7 I find direct causal evidence that individual ritual serves a palliative function, buffering against experiences of negative affect. I find that arbitrary ritual actions are capable of muting the neuroaffective response to performance failure, consistent with the experience of a person being less affected by sources of conflict/uncertainty (Study 6). Broadly speaking, within a neural performance-monitoring domain, this pattern of a reduced ERN in response to performance failure is also consistent with other research highlighting the neurophysiological regulation of distress, anxiety, and uncertainty (e.g., Hajcak, McDonald, & Simons, 2004; Jackson, Nelson, & Hajcak, 2016; Tullett, Kay, & Inzlicht, 2014). Further, the notion that rituals could act as a palliative (a dampened ERN) aligns with similar research showing that religious belief acts as a buffer against the pang of anxiety felt from self-generated failure (e.g., Inzlicht, McGregor, Hirsh, & Nash, 2009; Good, Inzlicht, & Larson, 2015; Inzlicht & Tullett, 2010), a general buffer response that might help religious people and ritual practitioners cope with ambiguity and uncertainty. With the degree of overlap between ritual and religion, it is reasonable to expect they share common neural processes/correlates. Indeed, it is thought that ritual precipitated formal religious practice/belief, with archeological records indicating the earliest form of religious behavior began with burial rituals.

2 Future Directions and Other Testable Predictions

The experiments reported here were derived from a set of testable predictions grounded in the theoretical framework. There are, of course, a number of other logical hypotheses that were not tested here but are open for future examination. The main value of using this type of psychological approach is that it offers generative empirical tools that can be applied to formulate tractable hypotheses and to ultimately enrich our understanding of ritual. By seeing

ritual as a product of different psychological properties, as opposed to sociocultural constructions, researchers will begin to see ritual in a new light and be exposed to certain features of such behaviors that have previously gone unnoticed. Below, I elaborate on some of these next steps and future directions.

2.1 Regulating Social States

The sensorimotor processing that happens during sequenced, synchronized ritual is a possible mechanism helping explain to the link between collective ritual on group cohesion. As shown in Study 3, variations the amount of sequenced matching or behavioral synchrony can influence group functioning. Future work could further verify this account by examining other similar contexts under which synchrony either succeeds or fails. For example, there may be situations, like in recently formed groups, where certain ritual sequences are too complex for successful synchrony, and where increased likelihood of a failed ritual would interfere with effective group functioning. This account would also predict that synchronous performances become more complex as the group itself becomes more established and better coordinated.

The top-down conceptual processing of group ritual was not explicitly tested in the current research. Meaning expressions are a critical component of many collective rituals, but what is the exact causal impact of meaning on social regulation and group affiliation? The framework says that the more perceived meaning a ritual has, the greater the amount of group liking. By this account I would predict that a person assigned to complete a ritual with more perceived meaning (for example, by having them think carefully about why they are engaging in each step of the ritual) would show heightened affiliation with group members compared to a person engaging in rituals with less perceived meaning (for example, by having them think about the sequences instead). Relatedly, ritual settings are often imbued with feelings of meaning and self-transcendence. A person may feel more connected to the land, the music, the night sky, or other aspects of the environment when they engage in a ritual than when they engage in another group activity. In turn, this would impact how a person feels about others with whom the experience is shared. Meaningful environments – like the monumental architecture of religious centers of worship – may enhance the specialness of the ritual, further increasing a sense of group connectedness (e.g., Joye & Verpooten, 2013). In other words, doing a ritual in a mosque

or temple would elicit greater cohesion compared to doing the exact same ritual in a more mundane, less awe-inspiring setting.

2.2 Regulating Goal States

The framework proposes that ritual's symbolic narratives regulate goal states through the successful completion of a meaningful personal practice understood to be ritual (and not some other behavior). This successful ritual experience, in turn, generates incidental feelings of personal efficacy and confidence, fulfilling competence motivation (White, 1959). In other words, the successful completion of a ritual before an important task signals to an individual that they are competent and capable of being successful on the ensuing task (for a general account of self-signaling on action and decision-making, see Bodner & Prelec, 2003). This process can operate like a placebo – i.e., I believe that the ritual will help my performance on the next task, and having that belief increases the likelihood that I am successful. Alternatively, even if an individual does not believe a ritual will affect an upcoming performance, the ritual could still promote self-efficacy through a spill-over account – i.e., I feel a sense of success from completing the ritual, and that feeling of confidence increases the likelihood of success on an ensuing task.

Different predictions can be drawn from this account. For instance, how does perceived completion versus incompletion of a ritual influence later performance on a task? A person who is interrupted partway through their ritual would likely consider this a failed attempt. As much as a successful ritual signals confidence in upcoming tasks, so too does a failed ritual cast doubt on a person's ability during an anticipated performance. A related point is the attribution of a person's performance after the event. If a person fails at a performance, are they more likely to attribute their lack of success to the incorrect completion of the ritual rather than to the ritual itself or some internal source? Future work should examine this question to see whether rituals could in fact act as a hindrance to achieving ongoing performance goals rather than as an aid.

2.3 Regulating Emotion States

The framework proposes that the focused motor control required to complete ritual's low-level physical actions facilitates emotion regulation simply through the completion of the ordered

movements themselves. More specifically, the motoric rigidity of ritual actions satisfies a fundamental need for order, and may help to regulate emotion states especially in response to anxious events when control is lost (Boyer and Liénard, 2008; Lang et al., 2015). As shown in Study 7, segmented action units may work as an anxiolytic by blocking out aversive events. Extending this work, I would predict that less structured rituals (and by the same token, less complex rituals) will not be as effective in mitigating anxiety or gaining control compared to more structured (and complex) rituals. A related prediction is that although performing rituals may serve a short-term goal of reducing anxiety in the moment, such rituals may ironically become maladaptive in the long-run because people may learn to rely on them too much. Indeed, such fixated behaviors are reminiscent of different pathological conditions like obsessive-compulsive disorder (e.g., Jung & Dell, 1940).

Much of the work on ritual and emotion has looked at ritual's regulatory control as a tactic for down-regulating negative affect or mitigating anxiety. Less attention has been paid to ritual's ability to up-regulate positive affect. We know from anecdotal evidence that rituals are not done only in times of duress and anxiety. Many rituals, for instance, tend to happen during moments of happiness, like the many rites-of-passage in which the transition into, say, adulthood is met with cheerful anticipation. In these moments, the purpose of ritual may actually be to amplify and sustain positive feelings rather than alleviate potential negative feelings. In future work, researchers should examine how these underlying processes drive the effect of ritual on enhancing positive emotion states and how such rituals compare with those done to diminish negative emotion states.

3 Conclusion

The current dissertation sheds a new light on the study of ritual. I provide a brief summary of the science of ritual, and situate recent findings in a broad psychological framework to help explain its underlying processes. From this, I specify a series of predictions related to its three regulatory functions and discuss the findings from seven experiments that examine multiple causes and effects of the ritual experience. As demonstrated in this research, my process-based framework is a starting place for novel insights into the study of ritual. Importantly, it seeks not to replace the rich theoretical advances of traditional sociocultural accounts, but instead to add to

them. The perspective offered here will help unpack the mysteries of ritual, generating new questions and hypotheses, much like the ones I have laid out here. Though the field of psychology has remained quiet on the topic of ritual for decades, my research recognizes the value psychological research can add to our understanding of this remarkable and universal aspect of human behavior.

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Appendix A: Participant Instructions Used in Study 4

Offensive Instructions

As mentioned already, your team (Country A) will compete against another team down the hall (Country B) in a military style game for resources. The game is a shortened lab version of such board games as Risk and Settlers of Catan, in which the objective is to gain resources over neighboring countries in a quest to conquer some land. Each country will take its turn in the "war zone" room, alternating between your Country and Country B, until the timer goes off (the game will last total 25 minutes). The number of resources you end up with will determine whether your Country has won or lost.

From a random draw, your Country is beginning with zero resources and the other Country with twenty. Your job then is to be on the offense and to take away as many resources from the other Country as possible. If your Country manages to steal more than 10 resources (11 or more), then you win; if your Country only steals fewer than 10 (9 or less), then you lose; if you steal 10, it's a tie. The "rounds" of the game will test your group's physical strength/determination, collective intelligence, trusting behaviors, and strategic planning. More details of the game will follow.

But before the game starts, you'll first have to come up with a "battle" ritual that best matches your Country's **offensive** profile. You have 20 minutes before the battles begin to come up with the best, most fitting group ritual. First discuss the elements and features of your ritual (use the white board to write down ideas), and then practice it multiple times until you've got it down perfectly. Your ritual can include any sort of movement, sequence, vocalization, or combination of actions. The ritual that you come up with will determine your success in the game.

Defensive Instructions

As mentioned already, your team (Country A) will compete against another team down the hall (Country B) in a military style game for resources. The game is a shortened lab version of such board games as Risk and Settlers of Catan, in which the objective is to gain resources over neighboring countries in a quest to conquer some land. Each country will take its turn in the "war zone" room, alternating between your Country and Country B, until the timer goes off (the

game will last total 25 minutes). The number of resources you end up with will determine whether your Country has won or lost.

From a random draw, your Country is beginning with twenty resources and the other Country with zero. Your job then is to be on the defense and hold onto and protect as many of your resources from Country B. If your Country allows less than 10 (9 or fewer) resources to be taken, then you win; if your Country allows more than 10 (11 or more) resources to be taken, then you lose; if you hold onto 10, it's a tie. The "rounds" of the game will test your group's physical strength/determination, collective intelligence, trusting behaviors, and strategic planning. More details of the game will follow.

But before the game starts, you'll first have to come up with a "battle" ritual that best matches your Country's **defensive** profile. You have 20 minutes before the battles begin to come up with the best, most fitting group ritual. First discuss the elements and features of your ritual (use the white board to write down ideas), and then practice it multiple times until you've got it down perfectly. Your ritual can include any sort of movement, sequence, vocalization, or combination of actions. The ritual that you come up with will determine your success in the game.

Appendix B: Ritual Sequence Instructions Used in Study 5

Approach Style Ritual

1. Left stomp and squat + hands to thighs + clap. With each step crouch forward … Repeat on right side. Sequence is 4 steps forward – 4 steps back – 4 steps forward – 4 steps back.
2. With your hands in fists just above your head, take marching steps while alternating left and right foot. As you step, swing your elbow forward. Sequence is 4 steps forward – 4 steps back – 4 steps forward – 4 steps back.
3. Squat with leaning on the left side + swipe your left hand in front of you and bring it towards your body making a fist as you do. Repeat with the right side and arm. Sequence is 4 steps forward – 4 steps back – 4 steps forward – 4 steps back.
4. Squat down and spring back up as you throw your hands and arms over your head at the same, alternating left and right steps. Sequence is 4 steps forward – 4 steps back – 4 steps forward – 4 steps back.
5. Take a forward-leaning running stance: Stomp your left foot down (right foot back) + left hand up and right hand back. Alternate right side, so your right foot down (left foot back) + right hand up and left hand back. Sequence is 4 movements forward – 4 movement back – 4 movements forward – 4 movements back.
6. Left stomp and squat + swipe left and right thumb/hand across the throat + throw a left and right hook punch. Repeat with right stomp and squat. Sequence is 4 movements forward – 4 movements back – 4 movements forward – 4 movements back.

Avoidance Style Ritual

1. Starting with the left hand, cross your arms in front of your body + pull down your crossed arms 4 times while holding them in front of you. Repeat this sequence 4 times.
2. Bring up your right arm in front of your body on an angle, and holding it there, take 4 small pivots to the left; return to centre with 4 small pivots. Repeat on the other side: Bring up your left arm, and holding it there, take 4 small pivots to the right; return to centre with 4 small pivots. Repeat this 2 times.
3. Cross your arms upwards at your chest so your hands are touching opposite shoulders. Touch your shoulders 4 times, then release your crossed arms and swipe in front of your body. Repeat this sequence 4 times.
4. Look to the left + touch your right shoulder … Look to the right + touch your left shoulder. Do this twice on each side, and after swipe hands upwards in front of your body and look up with your head. Repeat this sequence 4 times.
5. Place your right behind your left, so it's closer to your body. Holding your hands like this, push your hands away from your body. Do this 4 times and bring your left (then right) hand in front of you while turning your head away. Repeat this sequence 4 times.

Appendix C: Tower and Gate Task Instructions for Study 5

Offensive Strategy Instructions

Your army is on the offense and launching an attack against the defending enemy's castle. The duration of the war will take place over 9 separate rounds. Within each round, your group has to decide on one of two battle tactics: ***Attack the gate or attack the tower.***

As the attacking army, you have **0** new resources to begin the war. The defensive army's resources – they begin with 20 – are for the taking. To win, your army needs to **steal away** as many resources from defending enemy as possible. Resources can only be earned at the end of each round by gaining access either through the tower or the gate.

How to win: Your army will win the war (and conquer the castle) if you **gain more resources** than the enemy protects. The enemy will win the war (and hold their castle's defense) if they guard more resources than you steal away.

In each battle round, successfully attacking **the tower** will earn your army 1 resource. Successfully attacking **the gate** will earn your army 2 resources. A successful attack happens when you decide on one entry-point (i.e., either the gate or tower) and the defending enemy places their army at the other entry-point. The trick is correctly guessing where they will put their defenses. Can your offense outsmart the defense?

Example battle at start of Round 1: If your group decides to attack the gate, and the defending army places their army at the tower, then you **won** the battle round and stole away 2 resources from the defense (as a result you now have +2 resources, the defense has +18 resources). If your army decides to attack the tower, and the defending army places their army at the tower, then you **lost** the battle round and the defense protects a resource (as a result you still have 0 resources, the defense still has +20 resources). And so on in this way, for 9 rounds.

NOTE: All members of your group need to agree on the same option before making your decision. A decision can only be made once there's complete consensus amongst the group. Resources will be accumulated over the nine battle rounds. As mentioned, if you steal more resources than the defending army protects, YOU WIN THE WAR! (Example, at the end you have 12 resources and the defense has 8 resources). But if the defending army holds onto more of

their resources than your army steals, YOU LOSE THE WAR! (Example, at the end you have 5 resources and the defense as 15 resources).

To begin playing: Sitting at your computer stations, await the referee's message on the GChat board – "Round 1: READY, GO!" – signaling the start of round 1. As soon as this message appears, you can discuss amongst your group members which offense tactic to go with. The person in the messenger role (randomly assigned to one person in the group) will enter the appropriate code (see below) into the GChat as soon as the group has come to an agreement. **You all have to agree on the decision! If you do not, you forfeit that round**. And remember, if your army is the first to decide, you get an increase in the number of resources potentially earned. Be quick, but be smart!

After each decision, the referee will enter who won/lost the battle round. The second round will begin shortly after the results are typed, again with a "Round 2: READY, GO!" You'll then make the round 2 decision like before. This will happen 9 times.

Important: There is no talking or discussing in between the rounds. Discussions can only start once the referee types "READY, GO!" after each round. Your group will be penalized (***automatic 5 points lost***) if we see that you are talking. Similarly, there is no typing in between rounds. You can only type your answer once the referee types "READY, GO!" after each round. You will be penalized (***automatic 5 points lost***) if we see that you are typing prematurely. Prepare yourself. The battle begins soon … wait for the experimenter before continuing.

Offensive Attacking Encrypted Codes:

- Battle Round 1: Gate = Foxtrot; Tower = Beta
- Battle Round 2: Gate = Zulu; Tower = Romeo
- Battle Round 3: Gate = Oscar; Tower = Alpha
- Battle Round 4: Gate = Beta; Tower = Golf
- Battle Round 5: Gate = Sierra; Tower = India
- Battle Round 6: Gate = Lima; Tower = Charlie
- Battle Round 7: Gate = Juliet; Tower = Whiskey
- Battle Round 8: Gate = Yankee; Tower = Uniform
- Battle Round 9: Gate = Quebec; Tower = November

Defensive Strategy Instructions

Your army is on the defense and guarding your castle from an enemy attack. The duration of the war will take place over 9 separate rounds. Within each round, your group has to decide on one of two battle tactics: ***Defend the gate or defend the tower.***

As the defending army, you begin the war with **20** resources that need to be protected. The attacking army – starting with no resources – is trying to steal these ones away from your castle. To win, your army needs to **protect** as many resources from attacking enemy as possible. Resources can only be protected at the end of each round by preventing access through the tower or the gate.

How to win: Your army will win the war (and hold the castle) if you **protect more resources** than the enemy steals. The enemy will win the war (and conquer the castle) if they steal away more resources than you guard.

In each battle round, successfully defending **the tower** will prevent the loss of 1 resource. Successfully defending **the gate** will prevent the loss of 2 resources. A successful defense happens when you decide on a defense-point (i.e., either the gate or tower) and the attacking enemy places their army at the same location. The trick is correctly guessing where you think they will launch their attack. Can your defense outsmart the offense?

Example battle at start of Round 1: If your group decides to guard the gate, and offense decides to attack the gate, then you **won** the battle round and prevented the stealing of 2 resources (as a result you still have +20 resources, the offense has none). If your group decides to guard the tower, and the offense decides to attack the gate, then you **lost** the battle round and lost 2 resources (as a result you now have +18 resources, the offense now has +2 resources). And so on in this way, for 9 rounds.

NOTE: All members of your group need to agree on the same option before making your decision. A decision can only be made once there's complete consensus amongst the group. Resources will be stolen or protected over nine battle rounds. As mentioned, if you guard more resources than the offensive army steals, YOU WIN THE WAR! (Example, at the end you have 12 resources and the offense has 8 resources). But if the offensive army steals away more

resources than your army protects, YOU LOSE THE WAR! (Example, at the end, you have 5 resources and the offense as 15 resources).

To begin playing: Sitting at your computer stations, await the referee's message on the GChat board – "Round 1: READY, GO!" – signaling the start of round 1. As soon as this message appears, you can discuss amongst your group members which defense tactic to go with. The person in the messenger role (randomly assigned to one person in the group) will enter the appropriate code (see below) into the GChat as soon as the group has come to an agreement. **You all have to agree on the decision! If you do not, you forfeit that round.** And remember, if your army is the first to decide, you can minimize the number of resources to be taken. Be quick, but be smart!

After each decision, the referee will enter who won/lost the battle round. The second round will begin shortly after the results are typed, again with a "Round 2: READY, GO!" You'll then make the round 2 decision like before. This will happen 9 times.

Important: There is no talking or discussing in between the rounds. Discussions can only start once the referee types "READY, GO!" after each round. Your group will be penalized (***automatic 5 points lost***) if we see that you are talking. Similarly, there is no typing in between rounds. You can only type your answer once the referee types "READY, GO!" after each round. You will be penalized (***automatic 5 points lost***) if we see that you are typing prematurely. Prepare yourself. The battle begins soon … wait for the experimenter before continuing!

Defensive Guarding Encrypted Codes:

- Battle Round 1: Gate = Mike; Tower = Papa
- Battle Round 2: Gate = Delta; Tower = Tango
- Battle Round 3: Gate = Victor; Tower = Bravo
- Battle Round 4: Gate = Kilo; Tower = Xray
- Battle Round 5: Gate = Flick; Tower = Mower
- Battle Round 6: Gate = Onside; Tower = Idyll
- Battle Round 7: Gate = Solo; Tower = Glee
- Battle Round 8: Gate = Limo; Tower = Condor
- Battle Round 9: Gate = Yoyo; Tower = Network

Appendix D: Video Stimuli Description for Study 6

Unpleasant (Negative) Videos:

1- Polluted river: A video of an extremely polluted and dirty river flowing with people wading in it
2- Hiroshima: A video of the physical and human destruction caused by the atom bomb dropped on Hiroshima
3- Watermelon: A video of a time lapsed rotting watermelon meant to elicit strong disgust
4- Holocaust: A video of human suffering and starvation of concentration camp survivors during the Holocaust
5- Surgery: A video of an open-heart surgery with blood spilling out of the patient
6- Face tumor: A video of a hospital patient who has a large grotesque tumor engrossing majority of his face
7- Dog: A video of a stray dog defecating soft stool in a public space
8- Pigs: A large group of pigs in filth eating raw chicken feed
9- Snakes: A large pit of hundreds of snakes crawling over one another

Pleasant (Positive) Videos:

1- Puppy: A video of a puppy playing and bouncing around a house
2- Beach: A video of a picturesque beach and oceanfront with lapping waves
3- Grand Canyon: A video of an aerial view flying over the Grand Canyon
4- Penguins: A video of a small gathering of penguins playing together and diving off an iceberg into the ocean
5- Mountain bike: A video of an adventurous mountain-biking ride with picturesque scene surrounding
6- Base jumping: A video of an adventurous, thrill-seeking base jump
7- Field: A video of a beautiful scenery in a Thai rice field
8- Flysuit: A video of an adventurous, thrill-seeking flysuit jump showing an impressive mountainous landscape
9- Waterfall: A video of an impressive view of Niagara Falls

Neutral Videos:

1- Car: A video of a car driving down road
2- Planes: A video of planes landing in the distance
3- Photocopier: A video of an office photocopier making copies
4- Keyboard: A video of a person typing on a laptop keyboard
5- Home Tour: A video of a women walking through her apartment
6- Tractor: A video of a front-loader hauling rock and rubble
7- Clothesline: A video of a clothesline with hanging garments
8- City: A video of a city view with timelapse
9- Windfarm: A video of windmills on a windfarm

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The content of Chapter 2 is currently in press in Psychological Science:

Hobson, N. M., Norton, M. I., Gino, F., & Inzlicht, M. (in press). When novel ritual impacts intergroup bias: Evidence from economic games and neurophysiology. *Psychological Science*.

[i] Though listed as separate, there is considerable overlap between the three functions. Any one ritual may actually be a combination of these three regulatory functions, with the differences mostly acting as conceptual distinctions for the purposes of our framework. We address this throughout the paper by highlighting examples where this is the case. The conceptual distinction here offers a useful way to begin thinking about the different forms of ritual in a comprehensive and coherent way.

[ii] Because we are examining an interaction between two categorical variables, one of which has more than two levels (i.e., 3 experimental conditions), the way to test for significance is by using a model comparison approach as we did here. The standard interaction terms that are in the output are ignored in such cases because they do not consider the variance accounted for by including the 3-level categorical variable in the nested model.

[iii] We tracked the number of times participants logged into the at-home survey and completed the Stoop task. To qualify for the lab portion of the experiment, participants needed to do the survey and task at least twice. Because our experimental manipulation relied on this longitudinal experience of the at-home portion of the study, to include participants who failed to do the tasks only once (or not at all) would compromise the manipulation of our independent variable. Four participants in total failed to comply and only completed the at-home task once. They were excluded from completing the in-lab portion but still offered credit.

[iv] Upon visual inspection of the ERP graphs, it appears there might be an effect of the Pe -- a later, slower moving error-related waveform that is thought to be tied to the conscious awareness of error commission. To explore this, we conducted similar analyses looking at the Pe as defined as the average mean amplitude between 200 and 400 ms following responses on error trials at the posterior electrode site, Pz. The model revealed a significant main effect of trial type, $b = 9.50$, $t(46) = 4.89$, $SE = 1.94$, $p < .00001$, 95%CIs = [5.59, 13.40], indicating that the Pe was larger for error responses ($M = 8.29$ μV, $SE = 1.35$) compared to correct responses ($M = -2.68$ μV, $SE = 1.02$). There were no other significant main effects or interactions (all $ps > .15$).

[v] As revealed in the suspicion probe at the end of the study sessions, none of the fifty participants were suspicious of the cover story, each one believing that their movement was actually being recorded with the apparatus.