The divergent effects of prayer on cognitive performance

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A thesis submitted for the degree of
Doctor of Philosophy at the University of Otago,
Dunedin, New Zealand
June 2017
Abstract

Prayer is a universal religious ritual, even among the secular. Although prayer is assumed to be beneficial, the empirical evidence is sparse. What rigorous research exists, concentrates on prayer’s subjective effects and correlates. There is reason to think that these subjective mechanisms could translate to objective performance, such that praying for an objective outcome might bring about that outcome (without divine intervention) through one or more cognitive mechanisms. The primary aim of this thesis was to examine prayer’s effects on cognitive performance, and the mediating mechanisms that could account for its effects.

In two experiments, one in which prayer content was controlled and another in which participants generated the content, prayer differentially affected anagram performance depending on participants’ supernatural beliefs. Believers performed better after praying than after one of several control manipulations, and the opposite was true for nonbelievers.

Several mechanisms were explored as potential mediators of these effects. In Studies 1 and 2, emotional and arousal accounts of prayer were considered. Study 1 showed that believers who prayed experienced increased arousal and positive affect, but Study 2 did not replicate these effects. Study 2 revealed initial evidence of an alternative attributional account of prayer. Believers who prayed not only performed better on the anagram task, but also reported more internal attributions of control over their performance. However, the results of Studies 3 and 4, which investigated prayer’s effects on attributions of control, in the absence of performance were inconsistent with this account. Study 3 suggested another potential mechanism, that believers who prayed perceived their prayers as more effective in improving their performance. However, expectancy perceptions did not translate into predictions about performance, casting doubt on this account. Study 5 examined two alternative mechanisms; social influence and self-control.
Preliminary results did not support a social influence account of prayer. However, results showed initial support for a self-control account of prayer, with prayer increasing the ability to forgo immediate rewards as religiosity increased. Study 6 investigated prayer’s effects on cheating, an activity associated with self-control. Overall, nonbelievers were less inclined to cheat than believers. Prayer acted as a self-control enhancement for believers (but not nonbelievers), decreasing their cheating to the level of nonbelievers.

Despite a number of limitations, most notably the absence evidence for a complete causal model, the six studies together provide a number of basic experimental and correlational findings regarding the relationship between religious belief, prayer, and performance. Future research should investigate the replicability and generalizability of these results.
Acknowledgements

People often attribute our accomplishments, such as our Ph.D. theses, to ourselves. However, research suggests that our behavior, thoughts, personality, and motivations, are continuously influenced by our environments (e.g., social relationships), genetics, and their interaction. Therefore, I would like to acknowledge the institutions and people that have contributed to the completion of this doctoral dissertation.

Thank you to the University of Otago for providing me with a scholarship and the opportunity to research here in Dunedin. I am grateful to the staff of the Psychology Department, particularly my advisor, Dr. Tamlin Conner for her constructive feedback and advice and Lindsay Robertson for his technical assistance. I am thankful for Dr. Buchanan, creator of the Statistics of DOOM youtube channel, whose videos taught me how to use R and understand latent growth models.

Thank you to my colleagues in the Social Cognition Lab, who have facilitated a nurturing and collaborative home away from home, filled with stimulating and enlightening discussions and debates. I am continuously inspired by their research and challenged intellectually by their ideas. I am thankful to call so many of them my friends.

I would like to express my sincere gratitude to my supervisor, Professor Jamin Halberstadt for his kindness, patience, guidance, and immense knowledge. I am enormously grateful to have Jamin as a role model of intellectual humility and integrity and for the opportunity to have researched under Jamin’s supervision in the Social Cognition Lab. I could not have imagined a better mentor during my Ph.D. study.

Thank you to my partner Tom. It was so affirming to share the research roller coaster with someone as consciousness and supportive as Tom. Finally, a heartfelt thank you to my family: To
my parents for their unconditional love, support, and encouragement. To my mother, who continuously inspires me with her ability to love, understand, and accept people, in all of their brokenness, for her optimism and her confidence in me. To my father, who has always seen the value of experiences, critical thought, and scientific progress, for encouraging my curiosity and love for learning and for prodding that I fulfill my potential, however I chose (and choose) to define it. To my siblings: Forrest, Nora, Michael, Maggie, and Alex for their love, friendship, advice, constructive criticism, and building of my character. A very special thank you to my sister Nora and my brother Alex, my dearest friends, for their companionship.
Table of Contents

Abstract .................................................................................................................................................... ii
Acknowledgements ............................................................................................................................... iv
Table of Contents ................................................................................................................................. vi
List of Figures ........................................................................................................................................ xi
List of Tables .......................................................................................................................................... xii
Chapter 1: Thesis Overview and Literature Review .............................................................. 1
Explaning Prayer ............................................................................................................................... 1
  Defining prayer .......................................................................................................................... 3
    Prayer as ritual ......................................................................................................................... 4
    Input: Needs motivate prayer ............................................................................................... 5
  Act: Prayer as communication ................................................................................................. 6
    Prayer in 3 dimensions: Direction, time, and place ............................................................ 7
  Output: Effects of prayer ........................................................................................................... 7
Multidimensionality of prayer: Attempts at reduction ........................................................... 7
  Types of prayer ...................................................................................................................... 8
    Focus on petitionary prayer ............................................................................................... 11
    Socio-cognitive assumptions of petitionary prayer .............................................................. 11
Subjective correlates and outcomes of prayer ................................................................. 12
  Pseudo-experimental and experimental research on prayer’s efficacy ......................... 14
    Relationships .................................................................................................................... 14
    Alcohol consumption ...................................................................................................... 15
Cognitive performance .................................................................................................................. 17
  Why would prayer affect cognition? .................................................................................. 17
    Relaxation ......................................................................................................................... 17
    Supernatural monitoring and social influence .............................................................. 19
    Executive functioning, self-regulation, and attention ......................................................... 21
Attention resources and bias ....................................................................................................... 22
  Attributions and locus of control ......................................................................................... 23
Religiosity ........................................................................................................................................... 25
  Views about God .................................................................................................................. 26
Attachment ...................................................................................................................................... 26
Prayer expectations ....................................................................................................................... 28
Summary and current thesis...................................................................................................... 29
Chapter 2 ....................................................................................................................................... 31
Study 1: Prayer and cognitive performance.................................................................................. 31
  Method...................................................................................................................................... 32
    Participants ............................................................................................................................ 32
    Design and measures ............................................................................................................. 33
      Additional measures ........................................................................................................... 35
    Procedure .............................................................................................................................. 37
  Results....................................................................................................................................... 40
    Performance .......................................................................................................................... 40
    Persistence ............................................................................................................................. 42
    Arousal .................................................................................................................................. 42
    Moderated mediation of performance by arousal ................................................................. 44
    Moderated mediation of arousal by performance ................................................................. 45
    Positive affect (pleasure) ....................................................................................................... 46
    Moderated mediation of performance by positive affect ...................................................... 48
    Additional analyses ............................................................................................................... 48
      Correlations ....................................................................................................................... 48
  Discussion ................................................................................................................................. 49
Chapter 3 ....................................................................................................................................... 53
Study 2: Prayer content and cognitive performance ..................................................................... 53
  Method...................................................................................................................................... 55
    Participants ............................................................................................................................ 55
    Design and measures ............................................................................................................. 55
    Procedure .............................................................................................................................. 57
  Results....................................................................................................................................... 58
    Performance .......................................................................................................................... 58
    Persistence ............................................................................................................................. 59
    Arousal .................................................................................................................................. 59
    Positive affect ........................................................................................................................ 60
    Prayer content ....................................................................................................................... 60
    Prayer content as a function of religiosity ............................................................................ 64
    Attributions ............................................................................................................................ 64
    Moderated mediation of performance by attributions of internal control ......................... 65
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Discussion</td>
<td>131</td>
</tr>
<tr>
<td>Review: Prayer’s divergent effects on cognitive performance</td>
<td>131</td>
</tr>
<tr>
<td>Limitations</td>
<td>136</td>
</tr>
<tr>
<td>Prayer</td>
<td>136</td>
</tr>
<tr>
<td>Religiosity</td>
<td>138</td>
</tr>
<tr>
<td>Anagrams and cognitive performance</td>
<td>139</td>
</tr>
<tr>
<td>Executive function, self-regulation, and attention</td>
<td>140</td>
</tr>
<tr>
<td>N.Z. to U.S.A. Sample</td>
<td>140</td>
</tr>
<tr>
<td>Exclusively western Christian demographic</td>
<td>142</td>
</tr>
<tr>
<td>Applications and implications</td>
<td>142</td>
</tr>
<tr>
<td>References</td>
<td>144</td>
</tr>
<tr>
<td>Appendix A</td>
<td>177</td>
</tr>
<tr>
<td>Appendix B</td>
<td>178</td>
</tr>
<tr>
<td>Appendix C</td>
<td>180</td>
</tr>
<tr>
<td>Appendix D</td>
<td>182</td>
</tr>
<tr>
<td>Appendix E</td>
<td>183</td>
</tr>
<tr>
<td>Appendix F</td>
<td>184</td>
</tr>
<tr>
<td>Appendix G</td>
<td>185</td>
</tr>
<tr>
<td>Appendix H</td>
<td>189</td>
</tr>
<tr>
<td>Appendix I</td>
<td>196</td>
</tr>
<tr>
<td>Appendix J</td>
<td>197</td>
</tr>
<tr>
<td>Appendix K</td>
<td>202</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1.1. The structure of prayer ............................................................... 5
Figure 2.1. Computer screen image of the Affect Grid ................................. 34
Figure 2.2. Computer screen image of an anagram puzzle ............................ 39
Figure 2.3. Computer screen image of a solved anagram puzzle .................... 39
Figure 2.4. Religiosity moderates the effect of passage label on performance .... 41
Figure 2.5. Religiosity moderates the effect of passage label on arousal ............ 44
Figure 2.6. Religiosity moderates the effect of passage label on positive affect ... 48
Figure 3.1. Religiosity moderates the effect of condition on performance ......... 59
Figure 3.2. Religiosity moderates the effect of condition on internal attributions of control for performance ................................................................. 65
Figure 3.3. Religiosity moderates prayer’s effects on perceptions of anagram ease 69
Figure 3.4. Religiosity moderates prayer’s effect on perceptions of writing ease 70
Figure 4.1. Religiosity moderates perceptions of cond. effectiveness ............... 81
Figure 4.2. Prayer’s effects, moderated by religiosity, on perceptions of anagram ease 83
Figure 4.3. Religiosity moderates expectations for anagram performance following prayer versus control ................................................................. 85
Figure 4.4. Computer screen image of the SC – IAT stage 1 instructions .......... 93
Figure 4.5. Computer screen image of the SC – IAT stage 1 error notification .... 94
Figure 5.1. Religiosity moderates prayer’s effect on discounting between small and large rewards as measured by hyperbolic k ................................. 108
Figure 5.3. Religiosity moderates prayer’s effect on the difference in discounting between small and large rewards as measured by immediate choice ratios .... 109
Figure 6.1. Cheating distribution count .......................................................... 123
Figure 6.2. 95% Confidence intervals of incidence rate ratio (IRR) and odds ratios (OR) .... 125
Figure A.H.1. Latent growth model showing religiosity’s moderation of prayer’s effect on changes in hyperbolic k between small, medium, and large rewards ................................. 192
Figure A.H.2. Latent growth model showing religiosity’s moderation of prayer’s effect on changes in immediate choice ratios between small, medium, and large rewards ................................. 195
Figure AJ.1. Rootogram assessment of fit, comparing observed and expected counts .... 201
List of Tables

Table 2.1. Model coefficients for the relationship between condition and performance, moderated by religiosity and mediated by arousal. .......................................................... 45
Table 2.2. Model coefficients for the relationship between condition and arousal, moderated by religiosity and mediated by performance.......................................................... 46
Table 2.3. Pearson’s correlations among dependent measures......................................................... 49
Table 3.1. Frequencies of LIWC categories and Pearson’s correlations with religiosity (SBS). . 62
Table 3.2. Model coefficients for the relationship between condition and performance, moderated by religiosity, and mediated by attributions of control. ........................................ 66
Table 3.3. Model coefficients for the relationship between condition and attributions of control, moderated by religiosity, and mediated by performance........................................... 67
Table 3.4. Pearson’s correlations among dependent measures....................................................... 72
Table 4.1. Pearson’s correlations among dependent measures....................................................... 87
Table 4.2. Pearson’s correlations of dependent measures. ............................................................... 97
Table 5.1. Pearson’s correlations among dependent measures....................................................... 111
Table 6.1. Pearson’s correlations between praying behavior, views about God, locus of control: God, and locus of control: Internal. .................................................................................. 127
Table AH.1. Comparison of model fits for hyperbolic k.............................................................. 191
Table AH.2. Comparison of model fits for immediate choice ratios............................................. 194
Table AJ.1. Hurdle model comparisons......................................................................................... 199
Chapter 1: Thesis Overview and Literature Review

Explaining Prayer

Prayer is and may have always been a universal human behavior. Indeed, the oldest physical evidence of written language, the Epic of Gilgamesh from ancient Babylon (c. 2750 B.C.E.), contains the earliest tangible evidence of prayer (Pratt, 1920). Prayer may have originated long before written language, however, as evidenced by the oral transmission, in the form of collective songs, of ancient tribes (e.g., Pygmies, Zulu’s, Masai, Hopi, and Sioux; di Nola, 1961; Heiler, 1932). Zaleski and Zaleski (2005) speculated that Neanderthals prayed for the well-being of the dead, interpreted by the “Shanidar 4” Neanderthal flower burial (60,000 B.C.E.). Shanidar 4 contains the remains of an elderly Neanderthal buried beneath a blanket of flowers and herbs. Solecki (1975) argued that funeral rites also represent a concept of spirituality and the afterlife.

All of the world’s major religions, including Christianity (2.2 billion adherents), Islam (1.8 billion), Hinduism (1 billion), Buddhism (376 million), Sikhism (23 million), Judaism (14 million), and Jainism (4.2 million), emphasize the value of prayer (Heiler, 1932; Pew Research Center, 2014). In 2014, 55% of Americans agreed with the statement “prayer is an important part of my daily life” (Pew Research Center, 2014). More Americans pray than engage in any other religious behavior (Wuthnow, 2008).

Prayer persists not only among religious and spiritual practitioners but also, counterintuitively, among secular individuals. Despite an unprecedented decline in religious membership, prayer remains prevalent among Americans (General Social Survey, 2014). Approximately 20% of Americans who have no religious affiliation report praying at least once a day (Pew Research Center, 2014). Research from the Netherlands, one of the most secular countries in the world (Halman, 2001; Lechner, 1996), indicates that even with a steady decline in
religious membership, approximately 33% of Dutch pray (de Hart, Dekker, Hellemans, & Jonkers, 2015).

Historically, researchers assumed that people prayed because prayer had positive effects (e.g., health and well-being). Zaleski and Zaleski (2005, p. 6) quote the medieval mystic, Mechtilde of Magdeburg, as arguing:

That prayer has great power, which a person makes with all his might. It makes a sour heart sweet, a sad heart merry, a poor heart rich, a foolish heart wise, a timid heart brave, a sick heart well, a blind heart full of sight, a cold heart ardent.

William James posited that during prayer “something is transacting” (James, 1902/2009, p. 351). James suggested:

Through prayer, religion insists, things which cannot be realized in any other manner come about: energy which but for prayer would be bound is by prayer set free and operates in some part, be it objective or subjective, of the world of facts (p. 351).

The anthropologist Friedrich Heiler (1932) proposed that in prayer “we have revealed to us the essential element of all religion… the ‘prevenience and giveness’ of the grace of God…” (p. 3). Former United States President George W. Bush, in his statement on the Abu Ghraib prison scandal, claimed that “Prayer teaches us to trust, to accept that God’s plan unfolds in his time, not our own” (States Government United, 2005). Despite rejecting religion, the sociobiologist Robert Trivers reports that praying helps him “to keep my anger under control, to be more compassionate…” (Hutson, 2016).
However, despite many claims about prayer’s efficacy, scientists do not know if, how, or why prayer “works”. What research exists focuses on the subjective correlates and effects of prayer (e.g., well-being). Yet, there is reason to think that these subjective mechanisms could translate to objective performance, such that praying for an outcome might bring about that outcome (without divine intervention) through one or more cognitive mechanisms. Thus, the purpose of this thesis is to examine prayer’s effects on cognitive performance and to investigate the mechanism(s) by which prayer may influence performance. I begin with a review of the literature, discussing first the shift in the study of prayer, from theology and philosophy to the social sciences. Then, I review several psychological theories of prayer and the conflicting empirical evidence supporting and contradicting them. Finally, I discuss my own research questions, design, and the thesis outline.

**Defining prayer**

The scientific study of prayer is relatively new and has progressed only intermittently within the last century. This development represents a unique shift in the examination of religion, in which theological and philosophical theories of religion are increasingly being developed and subjected to scientific scrutiny by anthropology, sociology, and psychology. Such early stages of inquiry often consist of a random collection of studies in which researchers discover similar phenomena but describe and interpret them in different ways (Kuhn, 1970). Thus, operationalized

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1 The scientific study of prayer began in the early 1900’s but was abandoned in the following decade. The discipline was re-initiated in the late 1980’s. In 1920, Pratt protested that “so little attempt is being made to study empirically what is perhaps the most important and most vital fact of religion.” (p. 48). In 1985, Finney and Malony also found fault that “Nowhere is the longstanding breach between psychology and religion more evident than in the lack of research on prayer.” Francis and Evans noted that “the empirical study of prayer is an underdeveloped field of research.”
definitions of prayer are varied and imprecise (Gill, 1987). For instance, prayer has been defined as a “wish,” “self-therapy,” and a “way to God” (Dubois-Dumee, 1989, p. 4).

**Prayer as ritual**

Despite substantial variability, anthropologists, sociologists, and psychologists generally consider prayer a religious ritual (Baker, 2008; Janssen, de Hart, & Den Draak, 1990; Spilka, 2005). Staal (1996) described the structure of any ritual as having three parts: a beginning (entering the ritual), a middle (action), and an end (leaving the ritual), with the beginning usually mirroring the end. For instance, in some branches of Christian prayer, the petitioner begins the prayer with the sign of the cross, prays, and ends the prayer with the sign of the cross.2

In a content analysis of the Dutch youth’s prayer, Janssen et al., (1990) found a sequential, tripartite structure of prayer that mapped on to Staal’s analysis (Figure 1.1.). First, a need or problem occurs (e.g., illness), which initiates the entrance into the prayer ritual. Second, prayer arises as a response to and predicate of the need – the action (i.e., middle) of the ritual. Third, an effect occurs as the direct object, typically perceived abstractly and in general terms (e.g., feeling of calm). The subjective effect of prayer marks the end of the ritual. In other words, people’s problems, worries, and needs motivate their prayers, and their prayers typically result in an effect on the petitioner, such as feelings of inner strength.

Similarly, Lindgren (2005) observed a tripartite structure in Muslim prayer, following a linear temporal order (Figure 2). First, a complication or problem arises. Second, in response to the problem, prayer occurs. Prayer serves as a necessary but not sufficient condition for the solution of the problem. Third, prayer results in a denouement or effect, usually described by the

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2 The sign of the cross is a ritual blessing made by tracing an upright cross across the body.
petitioner as divine intervention.

\[ \text{A} \rightarrow \text{B} \rightarrow \text{C} \rightarrow \text{B} \rightarrow \text{A} \]

1. NEED 2. ACTION 3. direction 4. time 5. place 6. EFFECT

A \rightarrow B: entrance into prayer, motivated by a need, C: act of prayer, B \rightarrow A: output of prayer, : boundary ritual place.

*Figure 1.1. The structure of prayer: An adapted model of Janssen et al., 1990.*

**Input: Needs motivate prayer**

Heiler (1932) suggested that prayer originated among pre-agricultural people who had little control over the environment. According to Pratt, people are universally inclined to pray, “for the help we need, and for the good we want” (Pratt, 1920). In a review of several studies, need was emphasized as the impetus to pray (Finney & Maloney, 1985).

Baker (2008) reports that people most commonly pray to seek favor from the divine, petition for help, seek guidance, and manage emotions. Prayers for better health are among the most widespread forms of prayer (Zaleski & Zaleski, 2005). Negative emotion, (Welford, 1947) poor health (Welford, 1947) and chronic pain are three of the most frequently reported reasons for praying (Abraído-Lanza & Revenson, 1996). These topics reflect the motivation to meet unfulfilled needs (Finney & Maloney, 1985; Janssen et al., 1990).
Act: Prayer as communication

William James (1902/2009) defined prayer as “every kind of inward communion or conversation with the power recognized as divine” (p. 350). Strong (1909) concurred with James and hypothesized that prayer is primarily an “imaginative social process” that serves as a means for self-hood and personal development. Christian laypeople also agree with James, with “talking to God” being one of the most frequently identified and endorsed features of prayer by Christian laypeople (Lambert, Fincham, & Graham, 2011). By age four, children concur, perceiving prayer to be telepathic communication with God (Woolley & Phelps, 2001). Some psychological research is also consistent with James, contending that prayer and its cognates can be defined by two principles (Burdzy & Pargament, 2013; Sharp, 2012; Stark & Finke, 2000, p. 109): First, prayer is an act of communication. Second, the communication is between an individual or group of individuals and any human notion of the sacred.³

Prayer as communication implies a relationship between the petitioner and the entity to whom he or she prays (Spilka & Ladd, 2013, p. 11). Cerulo and Barra (2008) posited that a prayer’s perception of that entity’s disposition, power, and inclinations would influence the content of prayer. The act of petitioning implies attributions of power and omniscience to the entity petitioned. Generally, God is represented as a super-human (Barrett, 2001). The favors sought through prayer express the individual motivations and self-concept of the petitioner (Sharp, 2012). In sum, prayer can be defined as an act of communication between an individual or group of individuals and the perceived supernatural, that is affected by individual motivations, self-concept, perceptions of the supernatural, and the nature of the human-supernatural relationship (Sharp,

³ Throughout this thesis, God refers to the Abrahamic view of God, consistent with the religious beliefs of participants in the studies, but alternative religious traditions will be discussed in Chapter 7.
Prayer in 3 dimensions: Direction, time, and place

Prayer is sometimes characterized as an act of communication performed in a three-dimensional space, including time, place, and direction, as seen in Figure 1.1. (Janssen et al., 1990). Direction refers to the target of the prayer. Time denotes the temporal moment during which prayer occurs. Place indicates the location in which prayer occurs. God and deceased relatives are the most frequent targets of prayers, even for atheists (Bänziger, 2007; Janssen et al., 1990). People typically perceive such entities as ever-present, with a home location, “out there,” acting both in a supernatural place and in close proximity to them (Barrett, 2001). Thus, prayers to such entities can occur in any place and at any time (Bade & Cook, 2008; Sharp, 2010).

Output: Effects of prayer

The effects of prayer are typically characterized subjectively and abstractly by the petitioner (Janssen et al., 1990) and most of the literature focusses on these subjective correlates and effects. This thesis aims to examine how the subjective effects of prayer translate to objective cognitive performance and the mechanisms that can account for these effects.

Multidimensionality of prayer: Attempts at reduction

Prayer can be spoken or silent, formal or informal, and recited or sung (Spilka & Ladd, 2013, p. 12; Stark & Finke, 2000, p. 109). Prayer can be spontaneous or planned, public or private, and it can be communal or individual. Prayer can be institutionalized, individualized, and self-generated (Janssen et al., 1990).

In the early 1900s, scholars concurred that prayer was multidimensional but differed on what the dimensions were. Their initial efforts to describe prayer resulted in various typologies,
most of which were derived from observation and/or personal experience (Heiler, 1932; Pratt, 1920). Few prayer typologies were subjected to empirical testing until recently (Janssen, Prins, Van der Lans, and Baerveldt, 2000; Ladd & Spilka, 2002, 2006; Poloma & Pendleton, 1989; Poloma & Pendleton, 1991).

Types of prayer

Heiler (1932) theorized nine types of prayer in his classic, but largely untestable (Bänziger, 2007), model of prayer: the “primitive man’s” prayer (i.e., petitionary prayer), ritual prayer, the hymn, Greek cultural prayers (i.e., cultural prayer), philosophical prayer (i.e., meditative prayer), prayers of the great religious personalities, prayers of the great poets and artists, prayers in public worship, and prayers as individual religious duty. While many of Heiler’s classifications seem subjective and arbitrary (e.g., the prayers of the great religious personalities and great poets and artists), some are theoretically valuable. For instance, Heiler described petitionary prayer as the most basic type of prayer, which is motivated by fear and need for control and focused on the deliverance from negative conditions. Although Heiler classified this in reference to hunter-gatherers, it is relevant to current psychological theory. As discussed above, needs are frequently reported as the impetus to prayer. Heiler’s ritual and meditative prayer types are also applicable to current research. According to Heiler, when petitionary prayers are interpreted as being heard and answered, the petitioners progress into ritual prayer. Ritual prayer aims to reproduce efficacy via formulated and systematic methods. Meditative prayer is contemplation of the nature of the relationship between the creator and the creation.

Motivated by Heiler (1932), Poloma and Pendleton (1991) conducted a telephone survey on how frequently individuals practiced different praying behaviors. Factor analyses revealed four styles of prayer: Petitionary, ritual, colloquial, and meditative. As in Heiler’s framework,
petitionary prayer refers to asking God for material favors, while ritual prayer consists of reading and reciting formalized text. Colloquial prayer involves asking God for advice and forgiveness and prayers of thanksgiving. Meditative prayer involves worship, adoration, scriptural reflection, communication with God, and feeling God’s presence. Poloma and Pendleton (1991) reported, however, that the discriminant validity for colloquial and petitionary prayer was unsatisfactory— and suggested they may reflect the same factor.

Janssen et al., (2000) analyzed four of Heiler’s prayer types (petitionary, meditative, Christian, and individual prayer) in terms of seven dimensions suggested by their previous research (Janssen et al., 1990): the need that a prayer satisfies, the ritual act of prayer, the addressee to whom the prayer is directed, time of prayer, place in which people pray, methods of prayer, and the desired effects of prayer. The four types differed in terms of the weight given to these dimensions. In petitionary prayer, the desired effects of prayer were weighted most heavily, whereas in religious prayer, the direction of the prayer (i.e., toward God) was most important. In meditative prayer, the action of the prayer was the main theme. Finally, in psychological prayer, need was prioritized.

Janssen et al., (2000) content analyzed 687 Dutch undergraduate participants’ descriptions of their prayers in terms of the seven dimensions; the content analysis supported their theorized four types of prayer and provided the data for factor analyses. However, once again, there was ambiguity, this time between petitionary and religious prayer, with some items cross-loading, and further analyses suggested that the four proposed prayer types could be reduced to two: a combination of religious and petitionary prayer; and meditative prayer. Psychological prayer loaded onto the two factors almost equally, suggesting that perhaps psychological prayer underlies all prayer. Janssen et al., (2000) thus settled on three types of prayer: religious (combined with
petitionary), psychological, and meditative.

In 2007, Bänziger, using the same method as Janssen et al., (2000) confirmed the reliability of two of Janssen’s previously described prayer types: religious and meditative. Bänziger also concluded that petitionary prayer is a distinct type, with marginal conflation between petitionary and religious factor loadings. As in Janssen et al., (2000), psychological prayer was an underlying factor for all prayer types, suggesting that psychological prayer is not a specific category of prayer, but an inherent and underlying feature of all prayers.

Foster (cited in Ladd & Spilka, 2002) surveyed the theological and spiritual literatures on prayer and proposed yet another typology: inward, outward, and upward. Inward prayers concern self-reflection and self-development. Outward prayers pertain to human interpersonal relationships. Upward prayers relate to the human and God relationship. In 2002 and 2006, Ladd and Spilka factor analyzed questions about types of prayer with respect to Foster’s three-factor framework and developed a scale to measure it (Ladd & Spilka, 2006). Their work offers some support for Foster’s theory, though they did not find evidence for a general prayer factor or for an “inward” type of prayer (2002), but rather for two different types of outward prayer and one form of upward prayer. Furthermore, the distinction between outward and upward was somewhat empirically conflated. For instance, a person might pray to thank God for his or her relationship with God and with others.

As evidenced by this brief review, the scientific study of prayer is in its infancy, and more research is needed to resolve discrepancies and differentiate prayers, both conceptually and empirically. This effort is important because, theoretically, different types of prayer may have different motivations, function and effects. For example, Poloma and Pendleton (1991) found that different modes of prayer related differently to psychological well-being, with ritualistic modes of
prayer being associated with poorer outcomes (e.g., negative affect) and meditative and colloquial 
(conversational) types of prayer being correlated with positive outcomes (e.g., well-being).
Whittington and Scher (2010) found positive correlations between God-focused prayers (i.e., 
adoration, thanksgiving, reception) and measures of subjective well-being, and null or negative 
correlations between self-focused prayers and measures of subjective well-being.

**Focus on petitionary prayer**

Despite a lack of consensus on the varieties of prayer, petitionary prayer is consistently 
distinguished, theoretically and empirically, from other types of prayer (Bänziger, 2007; Janssen 
et al., 2000; Ladd & Spilka, 2002; Poloma & Pendleton, 1989, 1991), perhaps because it is the 
most easily understood. In petitionary prayer, which can be defined simply as a request to God 
(Stump, 1979), the ritual is clearly defined: the motive is to solve a need or problem, the action is 
the petitioning of God, and the effect is the solution to the problem that is sought (Janssen et al., 
2000). Some psychologists have suggested that petitionary prayer might be the oldest and most 
widespread form of prayer (e.g., Capps, 1982; Ellens, 1977; Gill, 1987). For example, Heiler 
(1932) suggested that “the free spontaneous petitionary prayer of the natural man exhibits the 
prototype of all prayer” (p. 1). Hendry (as cited in Capps, 1982) argued that all “prayer is basically 
petition” and “petition is the heart of prayer” (p. 26). Capps (1982) concurred: “the heart of the 
psychology of religion is the psychology of prayer, especially petitionary prayer” (p. 130).

**Socio-cognitive assumptions of petitionary prayer**

Due to its cross-cultural and historical ubiquity, religious cognition is presumed to be a 
product of ordinary human cognition. Specifically, theory of mind, among other developmental 
mechanisms, permits religious cognition and behaviors such as prayer to emerge (Bering, 2011;
Willard & Norenzayan, 2013). Theory of mind (TOM), also called mentalizing, refers to the ability to reason about the psychological states of oneself and others and to attribute intentions, beliefs, and emotions, individually and discriminately, to oneself and others (Willard & Norenzayan, 2013). Theoretically, one could petition a supernatural entity, conceptualized as an unthinking and unfeeling principle (e.g., the force), without TOM (e.g., Bering, 2011). However, most people conceptualize God(s) as a personal and psychological (rather than mechanical or biological) entity (Barrett, 1998; Barrett & Kiel). In addition, people demonstrate preferences for petitioning God via psychological causation rather than through biological or mechanical means (Barrett, 2001). Children above the age of 4 tend to agree, distinguishing praying from wishing via its psychic communication with God (Woolley & Phelps, 2001). Furthermore, in highly religious people, prayer appears to activate brain regions associated with social cognition, specifically, processing of social narratives and theory of mind (Schjoedt, Stødkilde-Jørgensen, Geertz, & Roepstorff, 2009). Schjoedt and colleagues (2009) interpreted these results to mean that highly religious participants who engage in personal prayer perceive God as a person, as opposed to an abstract object, and prayer could be comparable to other forms of social interaction.

Subjective correlates and outcomes of prayer

Most of the literature on prayer’s effects and correlates focuses on subjective outcomes, specifically, coping and well-being, not on whether praying achieves objectively measurable outcomes, such as cognitive performance. However, research on the former suggests hypotheses about the latter. Unfortunately, the literature relating prayer to well-being is complex and

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4 The force is a supernatural energy field that connects all life in the fictional Star Wars universe (“The Force,” n.d.).
5 Most studies described do not distinguish between types of prayer; in those cases, types of prayer are not specified.
inconsistent. For example, some correlational studies show a positive relationship between different types of prayer and well-being, but others indicate that at least certain types of prayer are related to worse well-being and psychopathologies. Poloma and Pendleton (1991) found that meditative prayer predicted existential well-being and religious satisfaction, while colloquial (i.e., personal/conversational) prayer correlated positively with happiness, and ritual prayers related positively to sadness, loneliness, and depression. Maltby, Lewis, and Day (1999) found that a higher frequency of personal prayer correlated negatively with trait anxiety and depressive symptoms and positively with higher self-esteem. Francis and Robbins (2006; 2009) and Francis and Kaldor (2001) found positive correlations between frequency of prayer and feelings of purpose in life. Francis and Fisher (2014) found positive correlations between prayer and happiness.

Some scientists suggest that prayer impacts well-being because it serves as a coping mechanism during times of stress (e.g., Andersson, 2008; Ashby & Lenhart, 1994; Baetz & Bowen, 2008; Dezutter, Wachholtz, & Coreveleyn, 2011; Keefe & Dolan, 1986; Rao, Sibbritt, Phillips, & Hickman, 2015; Rippentrop, Altmaier, Chen, Found, & Keffala, 2005; Rosentiel & Keefe, 1983; Schneider & Feltey, 2009). Schneider and Feltey (2009), for example, found that abused women reported coping via prayer, which made some of them feel comforted and gave them a sense of peace. However, they also reported feeling ignored, lonely, and hopeless as a result of unanswered prayers. Carson (1993) found correlations between frequency of prayer and psychological hardiness among long-term AIDS survivors. Multiple studies found correlations between prayer and chronic pain management successes such as adaptive coping, positive reappraisal, pain tolerance, and decreased pain (e.g., Baetz & Bowem, 2008; Dezutter et al., 2011; Rao et al., 2015). However, some studies suggest that using prayer as a coping mechanism for chronic pain is associated with greater disability, more demonstrative pain behavior, more reported
pain, worse physical health, greater use of medication, less activity, avoidance, lower perceived self-control, higher anxiety, greater depression, and passive and maladaptive coping (e.g., Andersson, 2008; Ashby & Lenhart, 1994; Keefe & Dolan, 1986; Rippentrop et al., 2005; Rosentiel & Keefe, 1983).

**Pseudo-experimental and experimental research on prayer’s efficacy**

Despite some intriguing correlational relationships between prayer and well-being, such research cannot determine the causal relationship between prayer and positive outcomes or reveal why or how prayer exerts its influence. However, there is a limited but growing experimental literature on the efficacy of prayer.

**Relationships**

In three studies, Fincham, Lambert, and Beach (2010) found that prayer may discourage the praying partner’s infidelity. In Study 1, Fincham et al., (2010) discovered that participants who prayed for their partner were less likely to cheat on them, even when controlling for relationship satisfaction. In Study 2, they found that participants who were randomly assigned to pray for their partner, for 4 weeks, cheated less (in thought and act) than participants in an undirected, daily diary control condition (“think about things you did today”), and a partner positive control (in which they recorded positive thoughts about their partner). In Study 3, Fincham and colleagues found that participants who were randomly assigned to pray for their partner, over the course of four weeks, tended to be rated by observers as more committed than participants who thought positive thoughts about their partner, though the difference was not statistically significant.

In two studies, Lambert, Fincham, Stillman, Graham, and Beach (2009) found that praying
increased forgiveness for a romantic partner and/or friend. In Study 1, participants who prayed for their partners expressed less gratitude for their partners than those in a control condition. However, when Lambert et al., controlled for religiosity, prayer frequency, gender, and gratitude, they found that praying increased forgiveness of a partner compared to a control condition (imagined conversation with parent about the partner’s physical appearance). In Study 2, participants who prayed for a friend over the course of four weeks reported being more willing to forgive their friend and reflected greater selfless concern for others than participants who engaged in undirected prayer or participants who thought positive thoughts about a friend. Greater selfless concern for others mediated the effect of friend-directed prayer on forgiveness.

Bremner, Koole, and Bushman (2011) found that following provocation, praying decreased anger and aggression against a target person compared to a control (thought) condition. Furthermore, they found that prayer changed the angered participants’ cognitive appraisals. Participants who were provoked and prayed for an unrelated person after the provocation reported less anger (Study 1) and lower anger-typical likelihood estimates of certain fictitious events (Study 3). Participants who were asked to pray for the person who had insulted them retaliated less against this person when given the opportunity to do so (Study 2). Participants who had prayed for another person were better able to control their aggressive impulses than participants who had only thought about this person.

**Alcohol consumption**

Lambert, Fincham, Marks, and Stillman (2010) found in a correlational study and longitudinal study that frequency of prayer was negatively correlated with alcohol consumption, and a greater frequency of prayer predicted less alcohol consumption and problem drinking over a three-month time span. In two experimental studies, they found that participants who were
randomly assigned to pray daily for four weeks reported less alcohol consumption than participants randomly assigned to write in a journal daily.

In a recent study, Galanter, Josipovic, Dermatis, Weber, and Millard (2016) found that participants (long term members of AA who had experienced a “spiritual awakening”) who read aloud from an AA prayer reported fewer alcohol cravings when presented with alcohol-craving-inducing stimuli than participants in passive control (i.e., do nothing) or news control (i.e., reading unrelated news) conditions. Functional magnetic resonance imagining revealed that participants who prayed exhibited increased activation of neural mechanisms associated with endogenous attention, goal maintenance, emotion-regulation and reappraisal, self-cognition, and visual-spatial processing (i.e., left-anterior middle frontal gyrus, left superior parietal lobule, bilateral precuneus, and bilateral posterior middle temporal gyrus) compared to participants in control conditions.
Cognitive performance

As discussed, most prayer research focuses on the subjective correlates and effects of prayer. These subjective outcomes could affect a number of processes, such as attention, self-control, and self-presentation, which are important to performance on cognitive tasks. For instance, prayer’s effects on problem solving (or indeed relationship quality and alcohol consumption) could be mediated by task persistence (via self-control), which is known to affect task performance in many domains (e.g., Zajonc, 1965; Baumeister, Bratslavsky, Muraven, & Tice, 1998). Prayer’s effect on cognitive performance has not been systematically examined, and is the subject of this thesis.

Why would prayer affect cognition?

Relaxation

Some researchers have theorized that prayer might produce positive cognitive outcomes via relaxation, mainly through the bodily actions associated with prayer (Benson, Greenwood, & Klemchuk, 1975; Benson, Kotch, Crassweller, & Greenwood, 1977; Goldberger & Breznitz, 1982 as cited in Spilka et al., 2013; Hughes, 1997; McCullough, 1995) but also through social buffering by attributions to God (e.g., Belding, Howard, McGuire, Schwartz, & Wilson, 2010). Through relaxation, prayer may decrease task related anxiety and the stress response to a more optimal level of arousal, increasing focus and facilitating cognitive performance (Cohen, 2011; Zajonc, 1965). Alternatively, through relaxation, prayer could decrease arousal and motivation which could inhibit task performance (Cohen, 2011).

6 Wiegand (2004) reported, in a doctoral thesis, that prayer reduced cognitive performance, however, when Wiegand removed people who reported actually praying, the effect became non-significant. This research was not formally published and the full draft is not available.
The correlational evidence for prayer effects on relaxation is mixed. Some studies affirm a negative relationship between prayer frequency and blood pressure (e.g., Koenig et al., 1998) while other correlational studies have found no relationship (e.g., Yeager et al., 2006), and one study found that greater frequency of prayer predicted increased hypertension (Buck, Williams, Musick, and Sternthal, 2009). Elkins, Anchor, and Sandler (1979) found that prayer over a ten-day training period did not significantly reduce tension, as measured by EMG and the State - Trait Anxiety Inventory, even when considering different prayer types (Spielberger, Gorsuch, & Lushene, 1970). However, they found that frequency of prayer and faith in prayer’s efficacy predicted tension reduction.

Prayer shares some features with meditation (e.g., involves kneeling, breathing deeply, closing eyes, etc.), which have been shown to lower blood pressure and inhibit stress (Benson et al., 1978; Droit-Volet, Fanget, & Dambrun, 2015; Esch, 2014). However, unlike meditation, meditative prayer focusses on a supernatural or metaphysical entity (Brown, 1994 cited in Ladd et al., 2013). Newberg, Pourdehnad, Alavi, and d’Aquili (2003) found similar effects in cerebral blood flow in their comparison of three Franciscan nuns’ meditative (verbal)7 prayer and eight Tibetan monks’ meditation (focused on a visual image).8 Newberg et al., (2003) found some differences in blood flow to the inferior parietal region, which is associated with language. The Franciscan nuns who engaged in meditative prayer exhibited greater blood flow to the inferior parietal region, which is associated with language, than the Tibetan monks who meditated. These

7 Verbal meditative prayer is not defined. Newberg et al., (2003) describe making religious texts initially available and depict the nuns’ eyes as closed during the final 30 minutes of their prayers (prayer practice was 50 minutes)
8 The sample size for Newberg et al., (2003) study was notably small, comparing three Franciscan nuns’ prayers to eight Tibetan Buddhists’ meditation. Furthermore, brain imaging procedures may be manipulations in themselves, reducing the validity of findings (Ladd, Cook, Foreman, & Ritter, 2015).
results suggest that prayer can be distinguished from meditation in its use as social communication, as well as in its metaphysical focus. In addition to taking advantage of physiological mechanisms, prayer may also relax people through cognitive mechanisms, such as self-disclosure and perceived social buffering.

**Supernatural monitoring and social influence**

Prayer might also influence cognitive performance via social influence. Johnson and Krüger (2004) and Gervais and Norenzayan (2012), for example, argued for the supernatural monitoring hypothesis, which suggests that God concepts elicit the same social cognitive effects as other social interactions, such as perceived (non-divine) surveillance. Gervais and Norenzayan (2012) found that explicit God primes increased public self-awareness in the same way as thinking about others’ perceptions, but only for participants who believed in God. Implicit God primes increased public self-awareness for all participants, regardless of whether they believed in God or not, compared to controls, but only increased socially desirable responding for believers. The supernatural monitoring hypothesis is primarily viewed through its adaptive function in promoting large-scale cooperation and pro-social behavior (Johnson & Krüger, 2004; Gervais & Norenzayan, 2012). However, the presence of others has implications for individual performance as well. For example, according to Zajonc’s (1965) Drive Theory, an audience (whether real or imagined) can either improve or impair performance on a task, depending on the physiological arousal the observers cause. In theory, arousal (in both humans and nonhumans) increases an organism’s “dominant response,” which may be more or less suitable to good performance (e.g., depending on whether the task is complex, or whether the individual is an expert at it). For example, Travis

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9 God was primed implicitly, with participants unscrambling a sentence by removing a word to create sentences containing God concept words.
(1925) found that participants who were well practiced showed better hand-eye coordination on a pursuit-rotor task when in the presence of a passive audience compared to when they were alone. Similarly, the presence of a supernatural watcher may improve performance for an easy task, or when the watcher makes an individual feel at ease, but impair performance in difficult or anxious situations. Whether a particular instance of observation (whether mortal or divine) will improve or impair performance depend on factors such as the familiarity or difficulty of the task (Bond & Titus, 1983), the perception of challenge or threat in the situation (Blascovich, Mendes, Hunter, & Salomon, 1999), and perceptions of observers’ attentiveness (Cottreel, Wack, Sekerak, & Rittle, 1968) and supportiveness (Baumeister & Steinhilber, 1984).

Prayer in particular could increase cognitive performance because it is, at least from the perspective of the individual praying, a supportive social interaction, particularly when God is conceived of as loving and personal (Schwartz, 2007; Sharp 2010). Belding et al., (2010) found that praying decreased participants’ self-reported stress levels and systolic and diastolic blood pressures, after they experienced a stressful social situation (public speaking), compared to participants in a self-affirmation condition, in which participants read a passage affirming their value and abilities. Religiosity did not moderate the effects. Interestingly, most participants did not consider the prayer they read to reflect a typical prayer, suggesting that prayer may “work” even when participants do not think their prayer is “real.”

Hales, Wesselmann, and Williams, (2016) found that participants who were randomly assigned to pray undirected (versus self-affirm or think undirected), after being ostracized in a “Cyberball” game, demonstrated greater basic needs recovery (i.e., increased feelings of belonging, increased internal control, and greater feelings of meaningful existence) and increased positive affect compared to the undirected thinking condition (who wrote about whatever was on
their mind), but not compared to the self-affirmation condition. The effects were stronger for participants who expressed greater religious commitment.

As social support (i.e., perceived social buffering), prayer could also help petitioners manage their emotions (Sharp, 2010), decrease perceptions of situational threats, reduce loneliness, fulfill needs for belonging (Hales et al., 2016), relax and provide comfort (Belding et al., 2010), thus freeing up cognitive resources for cognitive performance. Indeed, perceived social connectedness and social support increase achievement motivation, persistence, and cognitive performance (Sarason, 1981; Walton & Cohen, 2007; Walton & Cohen, 2011; Walton, Cohen, Cwir, & Spencer, 2012). The opposite is also true, with social isolation, exclusion, and low social status impairing performance and decreasing self-control (e.g., Baumeister, DeWall, Ciarocco, Twenge, 2005; Baumeister, Twenge, & Nuss, 2002; Smith et al., 2008).

**Executive functioning, self-regulation, and attention**

Self-regulation is an important aspect of executive functioning, vital to success in cognitively demanding tasks (Schmeichel, Vohs, & Baumeister, 2003) and academic performance (e.g., Duckworth & Seligman, 2005; Mischel Shoda, & Peake, 1988). Several researchers have proposed that positive effects of religiosity could be mediated by self-control (for a full review see McCullough & Willoughby, 2009; Roundling, Lee, Jacobson, & Ji, 2012; Toburen & Meier, 2010; Watterson & Geisler, 2012). Roundling and colleagues (2012) and Toburen and Meier (2010) found that implicit religious primes, such as God, spirit, or divine, increased self-control (task persistence, discomfort endurance, temporal discounting) compared to controls. Toburen and Meier (2010) also found that priming god-related concepts increased anxiety compared to controls. Watterson and Giesler (2012) found that after self-control depletion, highly religious participants persisted significantly longer on an unsolvable anagram task, compared to less religious
participants. Like religious primes, prayer may increase and replenish self-control (Childs, 1983). Indeed, Friese and Wänke (2014a) and Friese, Schweizer, Arnoux, Sutter, and Wänke (2014b) discovered that a brief period of personal, undirected prayer just before an effortful self-control task (thought suppression) buffered the effect of self-control depletion on a Stroop task (Stroop, 1935). Friese and Wänke (2014a) found that the degree to which participants felt they were in a social interaction mediated the effects of prayer, supporting a social facilitation account of prayer.

As seen in Friese et al., (2014a, 2014b) prayer may improve cognitive performance by boosting self-control, helping people to subordinate immediate desires in the service of longer-term goals. Most religions outline specific and explicit standards for goals and values and provide motivation for conforming to them, often via supernatural rewards or punishments (e.g., karma, heaven, hell; Worthington, 1993). Prayer may serve to remind petitioners of their standards and ideals, or at least the consequences of violating them, promoting self-control. Prayer may also facilitate goal development (Lambert et al., 2009), or inspire self-monitoring, causing petitioners to reflect on inconsistencies between their behaviors and standards and ideals (McCullough & Willoughby, 2009).

**Attention resources and bias**

Kahneman’s influential resource model conceptualizes attention as cognitive effort possessing flexible capacity limits (1973). Attention capacity depends on a variety of environmental and psychological factors, such as level of arousal and perceptions of the meaningfulness of a task. Attention capacity is intimately related to executive functioning,

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10 Childs (1983) suggested a link between prayer and inner speech. Prayer might facilitate self-regulation of thoughts and action via inner speech.
including self-control and cognitive performance (Eggemeier & Wilson, 1991; Englert & Bertrams, 2015; Eysenck, Derakshan, Nazanin, Santos, & Calvo, 2007).

Adams, Kleider-Offutt, Bell, and Washburn (2016) suggested that prayer might affect attention capacity and attention bias. Adams and colleagues (2016) found that undirected prayer increased attention capacity, as measured by Stroop task performance and a visual search task, but only for highly religious participants. In a second study, Adams and colleagues found that prayer increased word response times on a lexical-decision task and increased relevant word finds on a computerized word-search task for all participants, but substantially more for highly religious participants. Adams et al., (2016) concluded that prayer focused attention on “concern-relevant” concepts or tasks. Praying about a concern could focus attention on the problem prayed about, decreasing attention capacity for other problems or tasks (Adams et al., 2016). Alternatively, praying about a problem may involve surrendering responsibility of a problem to the supernatural, which could release the person’s attention from the problem, increasing attention capacity for other tasks and biasing the individual’s attention towards more productive tasks (Adams et al., 2016).

**Attributions and locus of control**

Attribution theory describes peoples’ reasoning and beliefs about the causes of events and behaviors (Weiner, 1985). Attribution theory proposes that people seek to make sense of their experiences in order to control and predict future events, and to protect and enhance their self-esteem and self-concept. Weiner classified attributions along three dimensions: locus, stability, and controllability. Locus concerns the location of the cause, whether it is internal (dispositional) or external (situational) to the individual. Stability refers to whether the cause is likely to stay the same (stable) or change (unstable). Controllability relates to whether a person can control the cause.
Though the evidence is inconclusive, many studies have associated controllability in particular with task performance. Bandura and Wood (1989), for example, found that perceptions of controllability predicted increased self-efficacy, performance goals, and cognitive performance. A meta-analysis revealed strong positive correlations between self-efficacy beliefs and academic performance and persistence (Multon, Brown, & Lent, 1991). Manstead and van Eekelen (1998) found that perceived controllability and self-efficacy predicted achievement. However, Endler, Speer, Johnson, and Flett (2001) did not find evidence of a relationship. Experimental research indicates that manipulating perceived controllability and stability affects task performance after initial failure, with increased controllability predicting increased performance and vice versa (Coffee & Rees, 2011; Coffee, Rees, & Haslam, 2009).

Kay, Gaucher, McGregor, and Nash (2010) theorized that religion might act as an external source of control during times of uncertainty. Research from several disciplines confirms that humans are motivated to see the world as understandable and controllable (Greenberg, Porteus, Simon, & Pyszczynski, 1995; Heine, Proulx, & Vohs, 2006; Jost, Banaji, & Nosek, 2004; Kruglanski, 1989; Landau et al., 2004; Landau, Greenberg, Solomon, Pyszczynski, & Martens, 2006; Lerner, 1980; Whitson & Galinsky, 2008). Conversely, the perception that the world is random causes stress and anxiety (Proulx & Heine, 2008; Van den Bos & Lind, 2002; Lind & Van den Bos, 2002). Believing in one’s own sense of personal control counters beliefs about randomness and increases the sense that tasks are manageable and goals achievable.

It is unclear what prayer’s attributional implications should be. On the one hand, petitionary prayer may serve as a way to gain vicarious control through God, thereby increasing one’s internal locus of control (Kay et al., 2010; Pyszczynski, Greenberg, & Solomon, 1999; Rothbaum, Weisz, & Snyder, 1982; Spilka & Ladd, 2013). Some researchers have suggested that a high internal
locus of control is analogous to a relationship with a benevolent, omnipotent God (Gloss, 2009 cited in Spilka & Ladd, 2013; Kay et al., 2009; Kay et al., 2010). Welton, Adkins, Ingle, and Dixon (1996) found that a higher “God locus of control” correlated positively with internal locus of control benefits. On the other hand, prayers may be seen providing external attributions for events that, according to the research reviewed above, should negatively affect executive functioning and cognitive performance (Spilka et al., 1985). Or, prayer could have different attributional implications depending on the petitioner’s religious beliefs, and in particular the collaborativeness of his or her relationship with God.

Religiosity

The analysis above illustrates how one might predict differential effects of prayer depending on religiosity, although, as seen throughout the literature review, individuals do not need to believe in God to be influenced by divine thoughts. Even if participants do not endorse supernatural or magical thinking, they likely have implicit associations regarding prayer and the supernatural that, like other implicit associations, affect their behavior (e.g., Lindeman, Heywood, Riekk, & Makkonen, 2014). The literature on the interaction between religiosity and prayer is inconsistent. In some studies, prayer affects both the religious and non-religious similarly (e.g., Friese et al., 2014a, Friese et al., 2014b, Bremner et al., 2011). In others, the effects of prayer depend on religious beliefs (e.g., Adams et al., 2016; Gervais & Norenzayan, 2012; Schjoedt et al., 2009). Furthermore, some mechanisms of prayer effects should in theory depend more heavily on religiosity than others. For instance, supernatural monitoring likely requires that an individual believe in the entity that is doing the monitoring, whereas prayer-induced relaxation may occur regardless of belief, simply by virtue of the physical actions prayer requires. Other mechanisms, like attribution of control, may affect religious and nonreligious people in opposite ways,
depending on their personal theory of how God’s control relates to their own.

**Views about God**

Among religious people, perceptions of the God to whom they pray could moderate the effects of prayer. People who see God as loving and personal report greater self-esteem than people who see God as remote (Benson & Spilka, 1973; Spilka, Addison, & Rosenohn, 1975). Wong-McDonald and Gorsuch (2004) found that positive views about God predicted an increased internal locus of control (though Benson & Spilka, 1973, did not). People who see God as distant report higher levels of shame and symptoms of psychopathology than people who see God as loving (Benson & Spilka, 1973; Spilka et al., 1975).

Bradshaw, Ellison, and Flannelly (2008) examined views about God as a moderator of the relationship between frequency of prayer and mental health. They found a strong, positive association between frequency of prayer and symptoms of psychopathology (i.e., depression, anxiety, interpersonal sensitivity, phobic anxiety, obsessive compulsive disorder, somatization, paranoid ideation, and hostility), moderated by perceptions of God as distant. The opposite was also true, with frequency of prayer predicting fewer symptoms of psychopathology when God was viewed as loving and personal.

**Attachment**

The attachment perspective provides yet another framework for looking at views of God. Bowlby (1969, 1973, 1980; cited in Kirkpatrick, 2005) initially advanced attachment theory as an evolutionary theory of infant social development. According to Bowlby, the infant-caregiver relationship evolved because it facilitated infant survival. Attachment theory describes how infants seek close relationships with caregivers and how the nature of their early socialization with
caregivers predicts their social relationships and other cognitive, behavioral, and social factors across the lifespan (Ainsworth, 1979; Hazan & Shaver, 1987; Bartholomew & Horowitz, 1991).

Kirkpatrick and Shaver (1992) applied attachment theory’s three styles – secure, avoidant, and anxious – to people’s relationship with God. As in relationships between mortals, an avoidant attachment to God involves perceiving God as impersonal, distant, and uninterested. Securely attached people see God as loving and personal, close and responsive, and invested in them personally. Anxiously attached people see God as inconsistent. Sometimes they think God is warm and responsive but other times cold and unresponsive.

Divine attachment styles have affective implications. People with anxious attachments to God report greater negative affect, less positive affect, more anxiety, and more neuroticism (Ellison, Bradshaw, Flannelly, & Galek, 2014; Rowatt & Kirkpatrick, 2002), while people with avoidant attachments to God experience greater depression, psychosomatic symptoms, less life satisfaction, and more loneliness (Ellison et al., 2014; Kirkpatrick & Shaver, 1992). On the other hand, individuals with secure attachments demonstrate higher levels of life satisfaction and optimism and lower levels of depression, psychological distress, loneliness, and anxiety (Bradshaw & Kent, 2017; Ellison et al., 2014; Rowatt & Kirkpatrick, 2002).

Moreover, there is some evidence that such attachment styles interact with prayer effects. Ellison et al., (2014) found that for people with a secure attachment to God, frequency of prayer was negatively correlated with anxiety symptoms, while the opposite was true for people with insecure or avoidant attachments. Bradshaw and Kent (2017) found that prayer moderated the degree to which a secure attachment to God was positively correlated with self-esteem, optimism, and life satisfaction. Such effects are consistent with several proposed mechanisms of prayer. For example, people who appeal to an entity to whom they feel securely attached might enhance their
confidence or feelings of control, while appealing to an entity to whom they are anxiously attached might prompt anxiety and negative affect – all with downstream implications, including for cognitive performance.

**Prayer expectations**

Durkheim (1995/1912, as cited in Bänziger, 2007) theorized how prayer expectations might moderate prayer’s subjective effects. Durkheim argued that “The power of the rite (prayer) over minds, which is real, made them believe in its power over things, which is imaginary”. Prayer expectations appear to both moderate and mediate the effects of prayer on mental health (Jegindø et al., 2012; Krause, 2004; Krause, 2009; Krause & Hayward, 2013; Pössel, Winkeljohn Black, Bjerg, Jeppsen, Wooldridge, 2013). Individuals who believe that God answers their prayers in the way and at the time He believes is best for them (i.e., trust-based prayer beliefs), exhibit higher self-esteem and greater life satisfaction than people who believe God answers their prayers exactly as they intended Him to, immediately. Prayer expectancies may moderate the effects of trauma on psychological distress, with trust-based prayer beliefs buffering the negative effects of trauma on psychological distress compared to non trust-based prayer beliefs (Krause, 2009). Pössel et al. (2013) reported that trust-based prayer beliefs mediated the degree to which prayer frequency was correlated with depression, and partially mediated the extent to which prayer frequency was associated with anxiety and confusion. Jegindø and colleagues (2012) found that pain expectations mediated prayer’s effects on perceived pain sensation among religious people. Such effects are consistent with a large literature on expectancies generally (i.e., the self-fulfilling prophecy; Merton, 1948), and with regard to cognitive performance specifically (e.g., Levy & Langer, 1994; Oken et al, 2008; Suhr & Gunstad, 2005).
Summary and current thesis

In summary, much of the research of prayer’s effects focuses on its subjective effects, but these subjective effects have implications for executive functioning and cognitive performance. Therefore, the aims of this thesis were to examine the objective effects of prayer on cognitive performance and to identify potential mechanism(s) by which prayer may influence performance.

In Study 1 (Chapter 2), I manipulated prayer in a unique way, holding constant the content of participants’ statements across conditions, and examined objective performance on a subsequent anagram task. Cognitive performance is frequently measured using anagram tasks as they assess problem-solving abilities, divergent thinking, sustained attention, and persistence (e.g., Alexander, Hillier, Smith, Tivarus, & Beversdorf, 2007; Baumeister et al., 1998; Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Gavurin, 1967, 1975; Sarason, 1984).

Study 2 (Chapter 3) was a replication of the first study with a more traditional prayer manipulation that permitted participants to generate their own prayers (or control statements), as well as allowing me to analyze the content of prayers for differences across religious and nonreligious participants. In both studies, prayer interacted with religious belief, improving performance for religious participants but impairing performance for nonreligious ones.

Following up on an additional finding in Study 2 – that religious participants not only performed better when they prayed but made more internal attributions for their performance – two studies in Chapter 4 directly examined attributions prior to performance, measured both explicitly (Study 3) and implicitly (Study 4). Study 5 (Chapter 5) then examined an alternative mechanism, self-control, using a well-validated measure of delay discounting (the willingness to forego short term gains for longer term goals), and Study 6 (Chapter 6) studied the implications of the results on that measure in a novel cheating paradigm. Finally, in Chapter 7, conclusions from
the experiments were drawn, limitations discussed, and the implications of prayer’s effects were considered.
Chapter 2

Study 1: Prayer and cognitive performance

Study 1’s primary aim was to explore petitionary prayer’s effects on cognitive performance. Although never tested directly, the possibility that prayer could influence performance on, for example, an anagram task, is predicted from several known effects of prayer and prayer-like behavior. For example, prayer appears to work as a social support interaction (Hales et al., 2016) and as discussed in Chapter 1, perceptions of social support and social connectedness increase achievement motivation, perseverance, and performance (Sarason, 1981; Walton & Cohen, 2007; Walton & Cohen, 2011; Walton et al., 2012). If prayer makes people feel supported and socially connected, then it could also increase cognitive performance.

A second goal of this study was to garner initial evidence for two potential mechanisms (i.e., positive affect and arousal) by which prayer might influence performance. If prayer affects performance due to social buffering by God, for example, then prayer should increase positive affect, as found by Hales and colleagues, (2016), and positive affect should mediate prayer’s effects. Hales and colleagues (2016) found that praying freely and self-affirming after being ostracized increased positive affect and basic needs recovery compared to a control condition. Belding and colleagues (2010) found that prayer and self-affirmation worked similarly to decrease self-reported stress levels and systolic and diastolic blood pressures. If prayer affects performance through relaxation, then prayer should also decrease arousal levels and arousal levels should mediate prayer’s effects.

Although both religious and nonreligious people are known to pray at times, previous research suggests that prayer might be particularly effective for the religious. For example, Adams and colleagues (2016) found that undirected prayer increased dual-task response times on the
Stroop task and a visual search task, but only for the highly religious. Therefore, in Study 1, religiosity, operationalized as belief in supernatural entities and events, is tested as a moderator of prayer’s effects.

One of the first challenges in studying prayer in the laboratory is equating experimental conditions. Particularly if participants are permitted to recite their own prayers, it is unclear whether participants are saying equivalent things in different conditions. On the other hand, if participants are provided with prayers, it is unclear whether they are perceived as such? As an attempt to deal with this issue, Study 1 employed a novel prayer manipulation: all participants read the same passage, which was described as either a prayer, a meditative passage, or a statement. Because the passage was in Swahili, the content could be kept identical in all three conditions.

Cognitive performance was operationalized as the proportion of anagrams correctly solved. Anagram measures are widely used cognitive performance measures that require problem-solving skills, divergent-thinking, focused attention, and effort (e.g., Alexander et al., 2007; Baumeister et al., 1998; Elliot et al., 2007; Gavurin, 1967, 1975; Sarason, 1984). Task persistence was also measured as a second dependent variable.

**Method**

**Participants**

Study 1 aimed for 30 participants per between-subjects condition, for a total of 90 participants.\(^{11}\) Eighty-three undergraduate psychology students were recruited from the University of Otago psychology experiment participation website, in exchange for course credit, for a study

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\(^{11}\) Due to time constraints (i.e., the school year ended), Study 1 achieved 83 participants instead of 90.
on “beliefs and anagrams”. The 64 females and 19 males ranged in age from 18-27. Twenty-six participants (31%) reported their identity as religious (69% of them Christian).

**Design and measures**

Participants were randomly assigned to one of three conditions: Prayer, meditation, or control. In each condition, participants read the Lord’s Prayer translated into Swahili (using Google Translate; Google, 2013), which they believed to be either a prayer, a meditation, or a foreign language passage.

Task performance and task persistence, the primary dependent measures, were assessed in an anagram task (Sherman, as cited in Anderson, 2010; see Appendix A), composed of 20 anagrams of varying difficulty (percentage of people solving them in previous studies ranged from 8% - 100%; Sherman, as cited in Anderson, 2010). The anagrams were all between 5 and 6 letters and were presented in order of increasing difficulty. Performance was operationalized as the number of anagrams solved correctly; persistence was operationalized as the mean amount of time (in seconds) participants spent on anagrams that they ultimately failed to solve.

Arousal and positive affect were measured using the 9 x 9 Affect Grid (Russell, Weiss, & Mendelsohn, 1989), a mood scale consisting of two dimensions, pleasure and arousal (see Figure 2.1.). Participants clicked on a square to indicate their current mood. Russell et al., (1989) reported that this measure showed satisfactory convergent validity with other measures of pleasure and arousal and evidence of strong discriminant validity between pleasure and arousal. (Split-half reliability was .97 for arousal, and .99 for pleasure).

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12 All of the studies conducted as part of this project received ethics approval from the University of Otago’s Department of Psychology (Category B Proposals).
Religious belief was measured using Jong, Bluemke, and Halberstadt’s (2013) 10-item Supernatural Belief Scale (SBS), which measures endorsement of common beliefs about supernatural agents and situations (e.g., Human beings have immaterial, immortal souls.). The measure has been validated in New Zealand, Croatia, and Finland (Bluemke, Jong, Grevenstein, Mikloušić, & Halberstadt, 2016; Lindeman, Svedholm-Häkkinen, & Lipsanen, 2015), among other countries. Participants indicated their agreement on a 9-point Likert scale. Scores were

\[ \Omega = .81 \]

Jong and colleagues’ (2013) exploratory and factor analyses revealed the SBS to be one-dimensional (composite reliability was \( \Omega = .81 \). SBS scores were predictive of theoretically
averaged to create a SBS mean, with higher scores indicating greater religious beliefs.

Additional measures

Locus of control was measured on the 32-item Multidimensional Locus of Control Scale: God Revision (Levenson, 1974; Welton, Atkins, Ingle, & Dixon, 1996 cited in Hill & Hood, 1999), which includes four subscales: Internal (e.g., My life is determined by my own actions), Powerful Others (e.g., My life is chiefly controlled by people more powerful than me), Chance (e.g., To a great extent my life is controlled by accidental happenings), and God (e.g., What happens in my life is determined by God’s purpose). The original Multidimensional Locus of Control Scales (Levenson, 1974) reliably measures an internal locus of control and two types of external loci of control: Chance and powerful others (Levenson, 1973).

Levenson (1973) demonstrated the validity of the scale, particularly the uniqueness of the two external loci of control. Levenson’s multidimensional locus of control scale is widely used and has been translated into French (e.g., Loas et al., 1994), Dutch (e.g., Brosschot, Gebhardt, & Godaert, 1994), Chinese (e.g., Lao, 1978), and Japanese (e.g., Krampen & Wieberg, 1981). In addition, many researchers have adapted Levenson’s multidimensional locus of control scale into situation-specific scales (e.g., the relevant behavior and beliefs (e.g., Self-identified atheists scored lower than the non-religious, who scored lower than the religious) (e.g., SBS predicted importance of religion to identity and religious service attendance).

14 Internal consistency compared positively to Rotter’s (1966) I-E scale (Levenson, 1973). The Kuder-Richardson formula 20 (KR-20) reliabilities ranged from mid .60’s to high .70’s. Split-half reliabilities (Spearman-Brown) suggested reliability of .60. Test-retest reliabilities ranged from .60’s to .70’s.

15 Chance items and powerful others items formed two distinct factors (in a principal component factor analysis) and bordered on the ideal simple structure with virtually no overlap (Levenson 1972; Levenson, 1973). The chance and powerful others subscales were correlated with theoretically related behavior (e.g., activism and powerful others; perceptions of parental behavior and internal versus powerful others subscales; political orientation and chance subscale) (Levenson, 1973).
Multidimensional Health Locus of Control Scale; Wallston, Strudler Wallston, & DeVellis, 1978) and to include other subscales (e.g., God; Welton et al., 1996).

Welton and colleagues (1996) adapted and extended Levenson’s (1974) locus of control scale to include God control, and demonstrated the reliability and validity of the resulting God control subscale.16 (Among other things, they found that internal locus of control health and coping benefits were associated with high scores on internal locus of control subscale and with high scores on the God control subscales, leading them to suggest that the two might be interchangeable.)17 Participants indicated their agreement on a 9-point Likert scale, anchored at “Strongly disagree” and “Strongly agree.” Responses were averaged to create four composite scores, with higher means indicating stronger control beliefs in each domain.

Prayer behavior and experience were measured initially with two new questions assessing participants’ frequency of prayer and meditation, anchored at Never and More than once a day. Participants who reported praying went on to complete four demographic items (e.g., What have you prayed for in the last year? Please give some actual examples; see Appendix B) from the prayer experience questionnaire (Dein & Littlewood, 2008) and the 5-item prayer experience subscale of Poloma and Pendleton’s (1991) measure of prayer activity.18 Participants indicated the frequency with which they experienced a variety of prayer related phenomena (e.g., Felt a strong presence of God during prayer; see Appendix B) on four-point Likert-type scales anchored at “Never” and

16 Internal consistency was positive (.89). The God control items were distinct from the chance and powerful others subscales and correlated with theoretically relevant behavior (coping strategies & religiosity).
17 Borich and Paver’s (1974) results suggest that locus of control may not be a lasting trait; Rather, Borich and Paver (1974) provided evidence suggesting locus of control may be a situation-specific state and cannot be generalized to all situations or stimuli.
18 Poloma and Pendleton (1991) found a satisfactory internal reliability (α = .87) and evidence that the prayer experience subscale was one-dimensional. Breslin and Lewis (2010) replicated with an Irish population and found Cronbach’s (Cronbach, 1951) alpha of .91.
“Regularly.” Scores were averaged to create a single composite prayer experience score, with higher scores reflecting higher frequency of divine prayer experiences.

**Procedure**

All participants were run in individual light and sound attenuated experimental cubicles containing an iMac 21-inch workstation, on which all stimuli were presented and responses collected, using the stimulus presentation software, Superlab. After providing informed consent, participants were seated individually at computers and instructed to follow the directions on the screen. Participants completed a demographics form, followed by the prayer frequency, prayer experience, Locus of Control, and Supernatural Belief, scales, in that order, on SurveyMonkey (SurveyMonkey, 2013). Then, after completing another, unrelated procedure, participants were given the following instructions (differences among experimental conditions appear in square brackets):

This is a study about the usefulness of different preparatory strategies on cognitive performance. You will be presented with a series of 20 anagrams (scrambled words). Try to unscramble each anagram to form a real English word and type your answer in the text box provided. Some anagrams are challenging. If you find an anagram too difficult, you have the option of skipping to the next one; just press the “pass” button. Press the spacebar to continue.

You are in a [“prayer”] [“meditation”] [“foreign language”] condition. Research suggests that [praying, even if you don’t believe in God] [reciting a meditative passage] [speaking a foreign language], can improve performance. Therefore, I will ask you to say a [prayer] [such a passage] aloud before beginning the
anagram task. So as not to bias the study, the [prayer][passage] is in Swahili.

All participants were then told “please prepare by slowly reading the following Swahili prayer [meditation, passage] aloud.”

Baba yetu aliye mbinguni, Jina lako takatifu; Ufalme wako uje, Mapenzi yako yafanyike, duniani kama mbinguni. Uupe leo mkate Itu wa kila siku, Utusamehe dhambi zetu, kama tunavyowasamehe wale ambao dhambi juu yetu; wala usitutie katika majaribu, lakini utuokoe na uovu.

Then, all participants were instructed to complete the anagram task. A reminder was presented on the screen for each anagram reading:

Try to unscramble each anagram to form a real English word and type your answer. DOUBLE CLICK on the solve button to solve the anagram. You will be presented with a text box to submit your answer. Press ENTER to submit. If you find an anagram too difficult, you have the option of skipping to the next one; just DOUBLE CLICK on the pass button.

As seen in Figure 2.2. and Figure 2.3., participants saw the anagram and chose to pass or solve by double clicking on the pass or solve button. If a participant chose to pass, then he or she was taken to the next anagram. If a participant chose to solve, then he or she was presented with a text box to enter the unscrambled word.
Figure 2.2. Computer screen image of an anagram puzzle.

Figure 2.3. Computer screen image of a solved anagram puzzle.

Upon finishing the anagrams, participants reported their mood using the affect grid.

Finally, I debriefed participants and thanked them for their time.
Results

In all analyses, Cook’s distance was used to identify and remove outliers that were overly influencing linear regression models (Cook, 1977).\(^{19}\) Religiosity (SBS score) was mean centered for all analyses.

Performance

Cook’s distance identified four outliers, leaving 79 participants. A one-way between-subjects’ ANOVA was conducted to analyze the effects of condition (prayer label, meditation label, or foreign language label) on anagram performance (number of 20 anagrams solved correctly), controlling for the mean time spent on the anagrams solved correctly. Condition did not account for differences in performance, \(F(2, 76) = 0.002, p = .10, \eta^2_p < .001.\)

Hayes’ (2012) “Process” software (Model 1) was used to analyze the effects of condition, religiosity, and their interaction on anagram performance, controlling for the mean time spent on the anagrams solved correctly. Conditions were dummy coded in order to allow for a multi-categorical independent variable. In D1, the prayer condition was dummy coded as 1 and the two control conditions as 0. The overall model was significant, \(F(4, 74) = 3.17, p = .018, R^2 = .15.\) D1 did not account for differences in anagram performance on its own, \(b = 0.04, SE_b = 0.87, t(74) = 0.06, p = .96, 95\% CI [-1.69, 1.79],\) consistent with the ANVOA result above. Religiosity predicted differences in anagram performance, with performance decreasing as religiosity increased, \(b = -0.48, SE_b = 0.21, t(74) = -2.28, p = .03, 95\% CI [-0.90, -0.06],\) and the effect

\(^{19}\) Cook’s distance identifies outliers that are having large effects on linear models. The measurement combines participants’ residual values and leverage values (Cook, 1977). Cook’s distance is calculated by removing data points from the analysis and recalculating the statistics. Then, it calculates the extent to which the statistics change as a function of individual data points (1977). Higher values signal a larger influence over the model. Any points higher than \(4/N – df\) were investigated.
was moderated by D1 (prayer), $b = 1.10$, $SE_b = 0.38$, $t(74) = 2.92$, $p = .01$, $\Delta R^2 = .10$, $f^2 = .12$, 95% CI [0.38, 1.85]. As seen in Figure 2.4., the interaction is due to prayer facilitating performance relative to controls (meditation and foreign language), as religiosity increases.

A similar analysis tested the equivalence of the control conditions (meditation versus foreign language). In D2, the meditation condition was dummy coded as 1, and the foreign language condition as 0. The overall model was not significant, $F(3, 48) = 1.82$, $p = .16$, $R^2 = .10$. Religiosity did not predict differences in performance, $b = -0.51$, $SE_b = 0.32$, $t(48) = -1.58$, $p = .12$, 95% CI [-1.15, 0.14]. D2 did not account for differences in performance, $b = -0.06$, $SE_b = 1.02$, $t(48) = -0.06$, $p = .96$, 95% CI [-2.10, 1.98]. Religiosity did not moderate D2’s null effects on performance, $b = 0.04$, $SE_b = 0.42$, $t(48) = 0.08$, $p = .94$, $\Delta R^2 < .01$, $f^2 < .01$, 95% CI [-0.81, 0.88].

![Figure 2.4](image-url)

*Figure 2.4. Religiosity moderates the effect of passage label (prayer or controls) on performance (number of anagrams solved correctly).*
Persistence

Five participants did not pass on any anagrams, and Cook’s distance revealed five outliers that were overly influencing the model, leaving 73 participants for the following analyses. A one-way between-subjects’ ANOVA was conducted to analyze the effects of condition (prayer label, meditation label, or foreign language label) on persistence, operationalized as the mean time in milliseconds participants spent on the anagrams before giving up (i.e., pressing the pass button). Condition did not account for differences in persistence, $F(2, 70) = 0.31, p = .74, \eta_p^2 = .01$.

Hayes’ (2012) Model 1 was used to analyze the effects of condition, religiosity, and their interaction on persistence. The three conditions (prayer label, meditation label, and foreign language label) were dummy coded as for the performance analyses. The overall model was not significant, $F(3, 69) = 0.60, R^2 = .03, p = .62$. D1 (prayer versus controls) did not account for differences in persistence, $b = 4.25, SE_b = 5.69, t(69) = 0.75, p = .46, 95\% CI [-7.11, 15.60]$. Religiosity did not predict differences in persistence, $b = -0.97, SE_b = 1.34, t(69) = -0.73, p = .47, 95\% CI [-3.64, 1.70]$. Religiosity did not moderate prayer’s null effects on persistence, $b = 2.97, SE_b = 2.61, t(69) = 1.14, p = .26, \Delta R^2 = .02, f^2 = .02, 95\% CI [-2.23, 8.17]$.

The overall model comparing the control conditions was not significant, $F(3, 45) = 0.52, p = .67, R^2 = .03$. Condition did not account for differences in persistence, $b = -2.81, SE_b = 6.80, t(45) = -0.41, p = .68, 95\% CI [-16.50, 10.88]$. Religiosity did not predict differences in persistence, $b = 0.55, SE_b = 2.11, t(45) = 0.26, p = .80, 95\% CI [-3.70, 4.79]$. Religiosity did not moderate condition’s null effects on persistence, $b = -2.70, SE_b = 2.81, t(45) = -0.96, p = .35, \Delta R^2 = .02, f^2 = .02, 95\% CI [-8.33, 2.97]$.

Arousal

Cook’s distance revealed three outliers, leaving 80 participants for analysis. A one-way
between-subjects’ ANOVA was conducted to analyze the effects of condition (prayer label, meditation label, or foreign language label) on arousal, as measured by the affect grid. Condition did not account for differences in feelings of arousal, $F(2, 77) = 0.79, p = .46, \eta_p^2 = .02$.

Hayes’ (2012) Model 1 was used to analyze the effects of condition, religiosity, and their interaction on arousal. The three conditions (prayer label, meditation label, and foreign language label) were dummy coded as above. The overall model was not significant, $F(3, 76) = 1.54, p = .21, R^2 = .06$. D1 (prayer) did not influence arousal, $b = 6.15, SE_b = 16.36, t(76) = 0.38, p = .71, 95\% CI [-26.44, 38.73]$. Religiosity did not account for differences in arousal, $b = -3.57, SE_b = -3.674, t(76) = -0.972, p = .33, 95\% CI [-10.89, 3.75]$. However, religiosity moderated prayer’s effects on arousal, $b = 15.18, SE_b = 7.26, t(76) = 2.09, p = .04, \Delta R^2 = .05, f^2 = .06, 95\% CI [0.72, 29.64]$. As seen in Figure 2.5., the interaction is due to prayer increasing arousal as religiosity increased, relative to controls.

The overall model comparing the control conditions was not significant, $F(3, 51) = 1.61, p = .20, R^2 = .09$. D2 did not affect arousal, $b = 19.01, SE_b = 17.65, t(51) = 1.08, p = .29, 95\% CI [-16.43, 54.46]$. Religiosity did not predict differences in arousal, $b = 2.72, SE_b = 5.22, t(51) = 0.52, p = .61, 95\% CI [-7.76, 13.20]$. Religiosity did not moderate D2’s null effects on arousal ratings, $b = -11.17, SE_b = 7.12, t(51) = -1.57, p = .12, \Delta R^2 = .04, f^2 = .07, 95\% CI [-25.45, 3.12]$. 


**Figure 2.5.** Religiosity moderates the effect of passage label (prayer, meditation, or foreign language) on arousal.

**Moderated mediation of performance by arousal**

The above analysis suggested that prayer, relative to controls, both increased performance and increased arousal, as religiosity increased. To test whether prayer’s effects on arousal could explain prayer’s effects on performance, Hayes’ (2012) Model 8 was used to analyze the direct and indirect effects of condition and arousal on performance, moderated by religiosity, with conditions (prayer or controls) as the independent variable, arousal as the mediator, religiosity as the moderator, and performance as the dependent variable, with 1000 bootstrap resamples.

Six outliers were identified, leaving 77 participants (Cook, 1977). The three conditions (prayer label, meditation label, and foreign language label) were dummy coded as above. Results indicated that arousal ratings mediated D1’s effects (moderated by religiosity) on performance, \(b\)
= - 0.18, $SE_{(boot)} = 0.13$, Boot 95% CI [-0.52, -0.01], as seen in Table 2.1.

Table 2.1.
Model coefficients for the relationship between condition and performance, moderated by religiosity and mediated by arousal.

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Arousal</th>
<th></th>
<th></th>
<th>Consequent</th>
<th>Performance</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
<td>$p$</td>
<td>$b$</td>
<td>$SE$</td>
<td>$p$</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>6.6</td>
<td>16.62</td>
<td>.69</td>
<td>-0.04</td>
<td>0.88</td>
<td>.97</td>
<td></td>
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<tr>
<td>Arousal</td>
<td>-0.01</td>
<td>0.01</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religiosity</td>
<td>-2.36</td>
<td>3.9</td>
<td>.55</td>
<td>-0.52</td>
<td>0.21</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>Cond * religiosity</td>
<td>13.97</td>
<td>7.41</td>
<td>.06</td>
<td>1.49</td>
<td>0.40</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R^2 = .05$</td>
<td> </td>
<td> </td>
<td>$R^2 = .18$</td>
<td> </td>
<td> </td>
<td></td>
</tr>
<tr>
<td></td>
<td>$F (3, 73) = 1.34, p = .27$</td>
<td> </td>
<td> </td>
<td>$F (4, 72) = 3.98, p = .01$</td>
<td> </td>
<td> </td>
<td></td>
</tr>
</tbody>
</table>

Moderated mediation of arousal by performance

While the results of the last analysis are consistent with an effect of prayer through arousal, the reverse causal path is also possible: Prayer may have affected performance directly, which then caused heightened arousal. Therefore, the model was tested again, with performance as the mediator and arousal as the dependent variable and with the same outliers removed (Cook, 1977). Results indicated that performance mediated D1’s effects (moderated by religiosity) on arousal, $b = -5.78$, $SE_{(boot)} = 2.92$, Boot 95% CI [-14.02, -1.35] (see Table 2.2.).
Table 2.2.
Model coefficients for the relationship between condition and arousal, moderated by religiosity and mediated by performance.

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Performance</th>
<th>Arousal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE</td>
</tr>
<tr>
<td>Condition</td>
<td>-0.12</td>
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<tr>
<td>Performance</td>
<td>-4.44</td>
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</tr>
<tr>
<td>Religiosity</td>
<td>-0.49</td>
<td>0.21</td>
</tr>
<tr>
<td>Cond * religiosity</td>
<td>1.30</td>
<td>0.40</td>
</tr>
</tbody>
</table>

\[ R^2 = .13 \]
\[ R^2 = .11 \]

\[ F (3, 73) = 3.64, p = .02 \]
\[ F (4, 72) = 2.17, p = .08 \]

Positive affect (pleasure)

Cook’s distance revealed four outliers, leaving 79 participants. A one-way between-subjects’ ANOVA was conducted to analyze the effects of condition (prayer label, meditation label, or foreign language label) on positive affect, as measured by the affect grid. Condition accounted for differences in positive affect, \( F (2, 76) = 3.2, p = .05, \eta_p^2 = .08 \). A post hoc Tukey test showed that the meditation label significantly decreased positive affect (\( M = -0.27, SE = 16.57, 95\% CI [-33.27, 32.74] \)) compared to the prayer label (\( M = 54.96, SE = 16.57, 95\% CI [21.96, 87.97] \)) at \( p = .05 \), but not compared to foreign language label (\( M = 45.74, SE = 16.26, 95\% CI [13.35, 78.13] \)), at \( p = .12 \). There was no statistically significant difference in positive affect between the prayer label condition and foreign language label condition, \( p = .92 \).

Hayes’ (2012) Model 1 was used to analyze the effects of condition (dummy coded as above), religiosity, and their interaction on positive affect. The overall model was significant, \( F \)
(3, 75) = 3.33, p = .02, $R^2 = .12$. D1 did not influence positive affect, $b = 25.02, SE_b = 20.08, t (75) = 1.25, p = .22$, 95% CI [-14.98, 65.02]. Religiosity did not account for differences in positive affect, $b = 1.73, SE_b = 4.71, t (75) = 0.37, p = .72$, 95% CI [-7.65, 11.10]. Religiosity moderated prayer’s effects on positive affect, $b = 18.01, SE_b = 8.69, t (75) = 2.07, p = .04, \Delta R^2 = .12, f^2 = .13$, 95% CI [0.71, 35.32]. As seen in Figure 2.6., the interaction is due to prayer increasing positive affect, as religiosity increases, relative to controls.

The overall model comparing the control conditions was not significant, $F (3, 49) = 1.47, p = .24, R^2 = .08$. D2 marginally accounted for differences in positive affect, $b = -45.00, SE_b = 23.05, t (53) = -1.95, p = .06$, 95% CI [-91.33, 1.325]. Religiosity did not predict positive affect, $b = -2.127, SE_b = 7.34, t (53) = -0.29, p = .77$, 95% CI [-16.88, 12.62]. Religiosity did not moderate D1’s effects on positive affect, $b = 5.52, SE_b = 9.61, t (53) = 0.58, p = .57, \Delta R^2 = .01, f^2 = .01$, 95% CI [-13.79, 24.84].
Figure 2.6. Religiosity moderates the effect of passage label (prayer, meditation, or foreign language) on positive affect.

**Moderated mediation of performance by positive affect**

Four outliers were removed that were overly affecting the model, leaving 79 participants (Cook, 1977). Hayes’ (2012) “Process” software (Model 8) was used to analyze the direct and indirect effects of condition and positive affect on performance, moderated by religiosity. Results suggested that positive affect did not mediate D1’s effects (moderated by religiosity) on performance, $b = 0.03$, $SE_{(boot)} = 0.10$, Boot 95% CI [-0.13, 0.28].

**Additional analyses**

**Correlations**

Correlations between prayer frequency, prayer experience, and locus of control (LOC)
were examined, as seen in Table 2.3. Participants who prayed more frequently also reported a more positive prayer experience.\(^{20}\) Participants who reported a more positive prayer experience, and who prayed more frequently, tended to report a higher God LOC. There was no relationship between an internal LOC and prayer experience, frequency of prayer, or God LOC.

Table 2.3.

*Pearson’s correlations among dependent measures.*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>.12</td>
<td>.01</td>
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<td>-.10</td>
<td>.27</td>
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<td>Arousal</td>
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<td>Pleasure</td>
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<td>-.01</td>
<td>.08</td>
<td>.06</td>
<td>.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Religiosity (SBS)</td>
<td>.77*</td>
<td>.80*</td>
<td>&lt;.01</td>
<td>.81*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Prayer experience</td>
<td>.82*</td>
<td>-.03</td>
<td>.78*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Frequency of prayer</td>
<td>.03</td>
<td>.80*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>LOC: Internal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>LOC: God</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.15</td>
</tr>
</tbody>
</table>

\(p < .001^*\) [Bonferroni corrected]

**Discussion**

Study 1’s primary aim was to explore how prayer affected task performance and persistence, either directly or in interaction with participants’ religious beliefs, as well as to explore possible mechanisms of any effects. In order to equate content across conditions, all participants

\(^{20}\) Participants completed the 5-item prayer experience subscale of Poloma and Pendleton’s (1991) measure of prayer activity if they reported praying (\(N = 48\)). Thirty-five participants reported never praying and did not complete the prayer experience subscale.
read the same Swahili passage that was described in one of three ways: prayer, meditation, or foreign language statement. Results showed that, compared to the two control conditions, religious participants solved more anagrams when they “prayed,” while nonreligious participants solved fewer. Seen another way, the advantage of prayer increased as a function of religious belief. There was no difference between the two control conditions.

The secondary aim was to explore the mechanisms by which prayer could influence performance and persistence. Results showed that religiosity moderated prayer’s effects on positive affect, and arousal: religious participants not only solved more anagrams when they prayed, but they also felt better and more energetic as they did so. In theory, either affective consequence of prayer could account for better performance – but the reverse mediational paths are also possible. Follow-up analyses showed that, in fact, affect is equally likely a consequence than a cause of performance. These results cast doubt on an account in which prayer relaxes the petitioner, although the possibility that participants were more relaxed prior to beginning the anagram task cannot be ruled out.

Prayer’s divergent effects on performance, while not necessarily explained by the arousal, are nevertheless consistent with several accounts of prayer’s efficacy, and their interaction with religiosity constrains somewhat the candidate mechanisms. For instance, participants who do not believe in God may not experience supernatural monitoring and its effects on perceived social surveillance, such as increased motivation. Alternatively, non-religious participants may experience the effects of an imagined audience, but perceive God negatively, and feel an increased stress response, performing worse on the anagram task. Prayer could also be affecting performance via self-regulation and executive functioning, priming of their standards and ideals, or differential attributions for performance. In particular, if prayer is a form of causal attribution that assigns
power to God, it may disempower non-religious participants by priming an external agent, decreasing their perceptions of their own agency and decreasing their performance. Conversely, prayer may empower religious participants, vicariously increasing their sense of control via God’s power and increasing their performance. In Study 2, this mechanism is examined.

Despite the promising results, Study 1 has a number of limitations. Most obviously, while the manipulation used in Study 1 may have controlled for explicit prayer content, “implicit” prayer content (i.e., what participants thought the words meant) was free to vary. These differential inferences may account for the differences in performance, rather than the act of praying itself. Relatedly, the prayer manipulation used in Study 1 may lack external validity, although it is arguably not dissimilar to the recitation of a Latin creed in a Catholic church or Hebrew psalm at a Jewish synagogue.

Therefore Study 2 was designed as a conceptual replication of Study 1, in which participants constructed their own prayers (or in a control condition, planned their day). Prayers were content analyzed and content was compared across levels of religiosity to investigate whether differences in prayer content could account for the variance in performance found in Study 1.

In addition to replicating Study 1, a second goal was to examine an attributional account of the effects: attributions of control. In Chapter 1, I suggested that such attributions could account for how prayer affects cognitive performance. If prayer serves as a means to gain vicarious control through God (Kay et al., 2010; Pyszczynski et al, 1999; Rothbaum et al., 1982; Spilka & Ladd, 2013) and a relationship with God is comparable to a high internal locus of control (Gloss, 2009 as cited in Spilka & Ladd, 2013; Kay et al., 2009; Kay et al., 2010), then prayer could increase

---

21 The difference between Study 1 and Study 2 is self-generated material. There is no self-generated task comparable to reading a foreign language. So, a planning control was tested as a control based on the daily diary control utilized by Lambert et al., 2010.
petitioners’ attributions of internal control and improve their cognitive performance. Attribution theory could also account for prayer’s deleterious effects on nonbelievers’ cognitive performance. For participants who do not have a relationship with God or who do not endorse supernatural beliefs, ascribing power to external entities could decrease attributions of internal control and impair cognitive performance (Spilka et al., 1985). Therefore, attributions of control are measured in Study 2. Affect and arousal were also retained as dependent measures.
Chapter 3

Study 2: Prayer content and cognitive performance

The findings from Study 1 indicate that the extent to which prayer (or at least the belief that one is praying) influences performance depends on one’s religious beliefs. A unique feature of the study was that all participants recited the same material, so differences in performance cannot be attributed to differences in explicit content. However, the design of the study did not preclude differences in implicit content: participants may have inferred different content, and it may be these differential translations, rather than the act of “praying” itself, that accounted for differences in performance. To address this limitation, Study 2 was designed as a replication of Study 1 that allows participants to construct their own prayers.

A second goal of Study 2 was to examine the content of participants’ prayers, to see if differences in content could explain the variability in prayer’s effects on performance in Study 1. Prayers were coded both manually and with an automatic content coder (Linguistic Inquiry and Word Count [LIWC]; Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007). Prayers were coded manually according to Poloma and Pendleton’s (1991) prayer typology as described in Chapter 1: petitionary and colloquial were merged (i.e., petitioning God for material or spiritual favors), ritual (i.e., formalized text), and meditative (i.e., worship and adoration). I made a limited number of a priori predictions about prayer content: Participants were expected to offer mostly petitionary prayers that referenced the anagram task and that included words related to achievement.

I also examined, for exploratory purposes, two linguistic variables that are associated with

22 LIWC processes and analyzes text based on dictionary categories and was designed for the assessment of psychological processes (Pennebaker, Mehl, & Niederhoffer, 2003).
positive affect, positive emotion terms and insight words. Abe (2009) found that positive emotion and insight words in a daily diary predicted clinical performance (as rated by practicum supervisors, perhaps via their association with cognitive broadening and flexibility). Furthermore, religious participants have been found to use more such words in prayers, particularly when coping with trauma (Bennett et al., 2013; VandeCreek, Janus, Pennebaker, & Biniau, 2002).\(^\text{23}\) Exploratory analyses compared psychological, perceptual, biological, and relativity processes between the religious and non-religious.

A third goal of Study 2 was to explore an attributional account of prayer, by measuring state attributions of internal control for performance. As argued in Chapter 1, from an attributional perspective, praying could influence success in a task by making salient internal or external attributions of control over performance. Previous research has shown performance benefits with manipulated perceptions of internal control (Coffee & Rees, 2011; Coffee et al., 2009). Similarly, prayer might serve as a manipulation of internal control, either by directly ascribing control to the self or by inferring control vicariously via an affirmation of external control by God (Kay et al., 2010; Pyszczynski et al., 1999; Rothbaum et al., 1982; Spilka & Ladd, 2013).

Finally, Study 2 aimed to explore how views about God might moderate prayer’s effects. For instance, Bradshaw et al., (2008) found that more negative views about God interacted with greater prayer frequency to predict more symptoms of psychopathology. Similarly, views of God may moderate prayer’s effects in the laboratory, with positive effects limited to those with a

\(^{23}\) Bennett and Elliott (2013) and Vandecreek and colleagues (2002) examined prayer as a form of self-disclosure, particularly in reference to coping with trauma. The prayers in this study are not framed within the context of trauma. Rather, they are framed within the context of task performance. Self-disclosure does not directly relate to task performance and was not considered as a potential mechanism.
positive view of God, perhaps independent of religious belief.

**Method**

**Participants**

A power analysis based on the effect sizes for religiosity’s moderation of prayer’s effects on performance ($f^2 = .10$) found in Study 1 using GPower (Faul & Erdfelder, 1992; for a full description, see Erdfelder, Faul, & Buchner, 1996) indicated that 101 participants were needed to achieve statistical power ($1 - \beta$) of 0.80 when $\alpha = 0.05$, two-tailed. One hundred and twenty-four first and second year psychology students were recruited from the University of Otago first and second year classes, who participated in exchange for course credit. The 77 females and 46 males (and one indicating their gender as “other”) were aged 17 to 36. Forty-nine (40%) participants reported their identity as religious (74% of them Christian).

**Design and measures**

Participants were randomly assigned to one of two conditions: Prayer or Planning (Control). In each condition, participants completed a writing task with the topic being either a prayer or planning exercise.

Task performance and persistence were measured using the anagram task as described in Study 1. State attributions for performance were measured on an adapted version of the 9-item revised causal dimension scale (CDSII; McAuley, Duncan, & Russell, 1992), which measures attributions for performance on four subscales: Locus of control, stability, personal control, and external control. McAuley et al., (1992) reported the reliability and validity of the causal
The CDSII was adapted in two ways. First, the CDSII was adapted to measure participants’ attributions for their performance on the anagram task, as opposed to an exam, gymnastic routine, bicycle ergometer task, or basketball game (McAuley et al., 1992). Second, the CDSII scale was reversed to run from 1 to 9 (rather than 9 to 1, as in the original) but the anchors remained the same (see Appendix C.).

Religiosity, arousal, positive affect, trait LOC, and prayer behavior and experience were measured as described in Study 1. The View of God Scale (VOGS; Shariff & Norenzayan, 2011) was added in Study 2 to measure participants’ positive and negative perceptions of God. The VOGS assesses seven positive traits associated with God (forgiving, compassionate, gentle, kind, comforting, and peaceful) and seven negative qualities (vengeful, harsh, fearsome, angry, punishing, jealous, and terrifying). The VOGS has not been adequately examined for reliability but has been demonstrated to have excellent discriminant validity and predictive validity (Shariff & Norenzayan, 2011). Participants who did not believe in God were instructed to rate instead “your culture’s perception of God or Gods.” Positive and negative traits were averaged separately to create two composite scores, one capturing negative view of God and one capturing positive view of God. The negative score was then subtracted from the positive score to create an overall positivity score.

As an additional measure, participants rated their perceived performance on the anagram task relative to their peers as a proportion, as well as the perceived ease of the writing task and

24 Internal consistency ranged from .67 to .82 and a four-factor model was an excellent fit (GFI = .958). The discriminant validity was lacking between personal control and external control but were found to be distinct when tried as a three-factor model, as a four-factor model provided the best fit.
anagram task on 7-point Likert scales, anchored at “Very difficult” and “Very easy,” with higher scores predicting greater ease (See Appendices D & E).

Procedure

The procedure was identical to that of Study 1, with the following exceptions: Participants completed the View of God Scale after the Prayer Experience Questionnaire and before the Multidimensional Locus of Control Scales. The survey was run on Qualtrics, an on-line survey platform, instead of SurveyMonkey (Qualtrics, 2015). Participants completed the prayer manipulation or the planning control on a worksheet, hidden in a folder, on the desk behind them. Participants were told:

You are in a [“prayer”] [planning] condition. Research suggests that [praying, even if you don’t believe in god,] [planning for the future] can improve performance. Therefore, I will ask you to write [a prayer] [your plans for tomorrow] before beginning the anagram task. Please limit your [prayer] [planning] to 3 sentences. You will have 5 minutes to complete your [prayer] [plans]. The computer will let you know when your time is up.

After five minutes, a timer on the computer made a beeping sound and instructed participants to complete the anagram task, as described in Study 1.

After finishing the anagrams, each participant’s mood was measured using the affect grid. Then, all participants were redirected to Qualtrics (Qualtrics, 2015) where they reported their attributions using the adapted CDSII, evaluated their performance, and rated their perceptions of the anagram task and writing task ease. Participants were debriefed and thanked for their time.
Results

In all analyses, Cook’s distance was used to identify and remove outliers that were overly influencing the models (Cook, 1977). Religiosity was mean centered for all analyses.

Performance

Five outliers were identified, leaving 119 participants (Cook, 1977). Hayes’ (2012) Model 1 was used to test the effects of prayer condition (prayer versus planning), religiosity, and their interaction, on the number of anagrams correctly solved, controlling for mean time spent on the anagrams solved correctly. The overall model was marginally significant, $F(4, 114) = 2.27$, $p = .07$, $R^2 = 0.07$. There was no main effect of condition, $b = 0.40$, $SE_b = 0.76$, $t(114) = 0.52$, $p = .60$, 95% CI [-1.11, 1.90]. However, religiosity significantly predicted performance, $b = 1.90$, $SE_b = 0.86$, $t(114) = 2.22$, $p = 0.03$, 95% CI [0.21, 3.60], and the effect was moderated by condition, $b = -0.81$, $SE_b = 0.33$, $t(114) = -2.46$, $p = .02$, $\Delta R^2 = .05$, $f^2 = .05$, 95% CI [-1.47, -0.16]. As seen in Figure 3.1., the interaction is due to the fact that prayer hinders performance relative to the control condition as religiosity decreases.
Persistence

Twelve participants did not pass on any anagrams, and Cook’s distance revealed four outliers, leaving 108 participants for analysis. The same analysis was used to analyze religiosity as a moderator of the effect of condition on persistence. The overall model was not significant, \( F(3, 104) = 1.30, p = .28, R^2 = .04 \). Condition did not affect persistence, \( b = -7.02, SE_b = 4.66, t(104) = -1.51, p = .14, 95\% \text{ CI} [-16.26, 2.22] \). Religiosity did not predict persistence, \( b = -1.79, SE_b = 1.32, t(104) = -1.36, p = .18, 95\% \text{ CI} [-4.42, 0.83] \). The interaction was not significant, \( b = 1.14, SE_b = 1.99, t(104) = 0.57, p = .57, \Delta R^2 < .01, f^2 < .01, 95\% \text{ CI} [-2.81, 5.08] \).

Arousal

Five outliers were removed, leaving 119 participants. The same analysis was used to
analyze religiosity as a moderator of the effect of condition (prayer or planning) on arousal ratings. The overall model was not significant, $F(3, 115) = 0.06, p = .98, R^2 < .01$. Condition did not affect arousal ratings, $b = 1.42, SE_b = 13.77, t(115) = 0.10, p = .92$, 95% CI [-25.85, 28.69]. Religiosity did not predict changes in arousal, $b = 5.85, SE_b = 15.02, t(115) = 0.39, p = .70$, 95% CI [-23.91, 35.60]. Religiosity did not moderate condition’s null effects on arousal, $b = -2.17, SE_b = 5.83, t(115) = -0.37, p = .71$, $\Delta R^2 < .01$, $f^2 < .01$, 95% CI [-13.72, 9.39].

**Positive affect**

Four outliers were removed, leaving 120 participants. Hayes’ (2012) Model 1 was used to analyze religiosity as a moderator of the effect of condition (prayer or plan) on pleasure ratings. The overall model was not significant, $F(3, 116) = 0.58, p = .63, R^2 = .02$. Condition did not influence positive affect, $b = -14.09, SE_b = 18.12, t(116) = -0.78, p = .44$, 95% CI [-49.96, 21.77]. Religiosity did not predict differences in positive affect, $b = 10.66, SE_b = 19.73, t(116) = 0.54, p = .59$, 95% CI [-28.42, 49.74]. Religiosity did not moderate prayer’s null effects on positive affect, $b = -2.61, SE_b = 7.63, t(116) = -0.34, p = .73$, $\Delta R^2 < .01$, $f^2 < .01$, 95% CI [-17.73, 12.51].

**Prayer content**

Participants’ written prayers were coded by a blind research assistant in terms of three categories based on the content of the prayers: petitionary (merged with colloquial), ritual, and meditative. However, initial coding indicated that all but three (57 of 60) participants in the prayer condition created petitionary prayers, so the data were recoded in terms of four subtypes of petitionary prayers: personal petitionary prayers (e.g., “Dear God, I pray that you can help me through the pain I have had lately. Amen.”; $n = 48$), petitionary prayers regarding the anagram task
(e.g., “Almighty God, give me the insight and wisdom to complete this anagram task. Thanks.”; \( n = 20 \)), petitionary prayers for others (e.g., “Dear God, I pray that you help my mum find a kidney soon so she can start travelling again”; \( n = 4 \)), and petitionary prayers for global issues (e.g., “Please God… give strength and mercy to those who need it. This critical period the world is entering requires guidance and kindness for all men and women”; \( n = 4 \)). A second research assistant independently coded 50% of the prayers and concurred 91% of the time with the first research assistant.

Second, Pennebaker and colleagues’ Linguistic Inquiry and Word Count (LIWC2007; 2007) software was used to content analyze participants’ prayers. As seen in Table 3.1., LIWC revealed that most participants referenced achievement related words (73%). Nearly all participants who prayed used positive emotion words in their prayers (98%) and about half of participants used insight words (57%).
Table 3.1.
Frequencies of LIWC categories and Pearson’s correlations with religiosity (SBS).

<table>
<thead>
<tr>
<th>Category</th>
<th>Linguistic processes</th>
<th>Example</th>
<th>$n$</th>
<th>SBS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tense</strong></td>
<td>past</td>
<td>went</td>
<td>13</td>
<td>-.08</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>is</td>
<td>51</td>
<td>.17</td>
</tr>
<tr>
<td></td>
<td>future</td>
<td>will</td>
<td>23</td>
<td>-.18</td>
</tr>
<tr>
<td><strong>Personal pronouns</strong></td>
<td>I</td>
<td></td>
<td>58</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>we</td>
<td></td>
<td>4</td>
<td>-.04</td>
</tr>
<tr>
<td></td>
<td>you</td>
<td></td>
<td>37</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>he/she</td>
<td></td>
<td>7</td>
<td>-.06</td>
</tr>
<tr>
<td></td>
<td>they</td>
<td></td>
<td>6</td>
<td>.16</td>
</tr>
<tr>
<td><strong>Social processes</strong></td>
<td>family</td>
<td>mom</td>
<td>11</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>friends</td>
<td>mate</td>
<td>7</td>
<td>-.06</td>
</tr>
<tr>
<td></td>
<td>other human relationships</td>
<td>adults</td>
<td>11</td>
<td>-.17</td>
</tr>
<tr>
<td><strong>Positive affective processes</strong></td>
<td>love</td>
<td></td>
<td>59</td>
<td>-.16</td>
</tr>
<tr>
<td><strong>Negative affective processes</strong></td>
<td>anger</td>
<td>fight</td>
<td>5</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>anxiety</td>
<td>worry</td>
<td>11</td>
<td>.22</td>
</tr>
<tr>
<td></td>
<td>sadness</td>
<td>grief</td>
<td>4</td>
<td>.05</td>
</tr>
<tr>
<td><strong>Cognitive processes</strong></td>
<td>insight</td>
<td>consider</td>
<td>34</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>causation</td>
<td>because</td>
<td>24</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>discrepancy</td>
<td>should</td>
<td>29</td>
<td>.01</td>
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<td></td>
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<td>maybe</td>
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<td>Category</td>
<td>Word</td>
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<td>-------------------------------</td>
<td>------------</td>
<td>-----------</td>
<td>---------</td>
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<tr>
<td>inhibition</td>
<td>constrain</td>
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<td>.17</td>
<td></td>
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<tr>
<td>inclusive</td>
<td>and</td>
<td>49</td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>exclusive</td>
<td>without</td>
<td>14</td>
<td>-.03</td>
<td></td>
</tr>
<tr>
<td>Perceptual processes</td>
<td>seeing</td>
<td>19</td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hearing</td>
<td>3</td>
<td>-.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>feeling</td>
<td>11</td>
<td>.02</td>
<td></td>
</tr>
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<td>Biological processes</td>
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<td>8</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>health</td>
<td>10</td>
<td>-.09</td>
<td></td>
</tr>
<tr>
<td>Relativity</td>
<td>motion</td>
<td>57</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>space</td>
<td>48</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>time</td>
<td>43</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>Personal Concerns</td>
<td>religion</td>
<td>50</td>
<td>-.06</td>
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<tr>
<td></td>
<td>achievement</td>
<td>44</td>
<td>.23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>work</td>
<td>32</td>
<td>-.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>money</td>
<td>3</td>
<td>-.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sexual</td>
<td>4</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>leisure</td>
<td>10</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>home</td>
<td>6</td>
<td>.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>death</td>
<td>1</td>
<td>.07</td>
<td></td>
</tr>
</tbody>
</table>

\[ n = 60, \ p < .001^* \text{ [Bonferroni corrected]} \]
**Prayer content as a function of religiosity**

Prayer content was correlated with SBS scores to ascertain if prayer’s divergent effects on performance might be explained by differences in what religious people pray for. As seen in Table 3.1, more religious participants discussed work in their prayers marginally less than less religious participants but were slightly more likely to use words related to achievement than less religious participants. However, following a Bonferroni correction required for multiple comparisons, none of the correlations were statistically significant.

**Attributions**

Four outliers were excluded, leaving 120 participants. The same analytic strategy was used to examine state attributions of internal control for anagram performance, controlling for trait internal LOC. The overall model was marginally significant, $F(4, 115) = 2.19, p = .08, R^2 = .07$. Condition did not account for the variability in attributions of internal control, $b = 1.25, SE_b = 0.81, t (115) = 1.55, p = .12, 95\% \text{ CI} [-0.35, 2.84]$. Religiosity marginally predicted attributions of internal control, $b = 1.61, SE_b = 0.93, t (115) = 1.74, p = .09, 95\% \text{ CI} [-0.22, 3.44]$. As seen in Figure 3.2, religiosity moderated the effects of condition on attributions of control: Internal, $b = -0.693, SE_b = 0.35, t (115) = -1.96, p = .05, \Delta R^2 = .03, f^2 = .03, 95\% \text{ CI} [-1.39, 0.01]$, with prayer decreasing attributions of internal control as religiosity decreased, relative to planning.
The main analyses show that prayer, relative to a planning control condition, both improves anagram performance and increases attributions of internal control, with greater religious belief. To determine whether the second effect might statistically explain the first, Hayes’ Model 7 was used to test for moderated mediation, using 1000 bootstrap resamples, with condition (prayer or planning) as the independent variable, attributions of internal control as the mediator, religiosity as the moderator, and performance as the dependent variable, controlling for trait internal LOC. Five outliers were removed, leaving 119 participants for analysis (Cook, 1977). The index of moderated mediation was significant, suggesting that internal attributions of control mediated condition’s effects (moderated by religiosity) on performance, $b = -0.23$, $SE_{(boot)} = 0.13$, 95% CI

**Figure 3.2.** Religiosity moderates the effect of condition (prayer or plan) on internal attributions of control for performance.
Table 3.2.

Model coefficients for the relationship between condition and performance, moderated by religiosity, and mediated by attributions of control.

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Internal attributions</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
</tr>
<tr>
<td>Condition</td>
<td>1.23</td>
<td>0.81</td>
</tr>
<tr>
<td>Internal attributions</td>
<td></td>
<td>0.33</td>
</tr>
<tr>
<td>Religiosity</td>
<td>1.63</td>
<td>0.93</td>
</tr>
<tr>
<td>Cond * religiosity</td>
<td>-0.73</td>
<td>0.36</td>
</tr>
</tbody>
</table>

$R^2 = .07$  

$F(4, 114) = 2.18, p = .08$  

Moderated mediation of internal attributions of control by performance

Although the results are consistent with an effect of prayer via attributions of internal control, the reverse causal path is also possible: condition might have influenced performance directly, which in turn produced differences in how that performance was attributed. To test this possibility, the model above was tested again, treating attributions as the DV and performance as a mediator, controlling for mean time spent on the anagrams solved correctly. The model again showed evidence of moderated mediation, $b = -0.26, SE_{(boot)} = 0.15$, Boot 95% CI [-0.62, -0.04] (see Table 3.3.)
Table 3.3.
Model coefficients for the relationship between condition and attributions of control, moderated by religiosity, and mediated by performance.

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Performance</th>
<th>Internal attributions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
</tr>
<tr>
<td>Condition</td>
<td>0.47</td>
<td>0.79</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religiosity</td>
<td>1.88</td>
<td>0.90</td>
</tr>
<tr>
<td>Cond * religiosity</td>
<td>-0.80</td>
<td>0.35</td>
</tr>
</tbody>
</table>

$R^2 = .07$ $R^2 = .34$

$F (4, 114) = 2.25, p = .07$ $F (3, 115) = 5.11, p = .002$

Positive views of God and performance

Five outliers were removed, leaving 119 participants. Hayes’ (2012) Model 1 was used to examine positive views of God as a moderator of the effect of condition (prayer or planning) on performance (number of anagrams solved correctly). The overall model was not significant, $F (2, 115) = 0.72, p = .54, R^2 = 0.02$. Condition did not directly influence performance, $b = 1.15, SE_b = 1.10, t (115) = 1.04, p = .30, 95\% CI [- 1.04, 3.33]$. Positive views about God did not predict differences in performance, $b = 0.75, SE_b = 0.80, t (116) = 0.93, p = .35, 95\% CI [- 0.84, 2.34]$. Positive views about God did not moderate condition’s null effects on performance, $b = - 0.24, SE_b = 0.32, t (115) = - 0.74, p = .46, \Delta R^2 = .01, f^2 = .01, 95\% CI [- 0.87, 0.40]$.

Positive views of God and state attributions of internal control

Four outliers were removed, leaving 120 participants. Hayes’ (2012) Model 1 was used to
test positive views of God as a moderator of the effect of condition (prayer or plan) on internal attributions of control, controlling for trait internal LOC. The overall model was not significant, $F(4, 115) = 1.68, p = .16, R^2 = 0.06$. Condition did not impact internal attributions for performance, $b = 1.10, SE_b = 1.13, t(115) = .97, 95\% CI [-1.14, 3.33]$. Positive views about God did not predict internal attributions of control over performance, $b < 0.01, SE_b = 0.837, t(115) < .01, p = .10, 95\% CI [-1.66, 1.66]$. Positive views about God did not moderate condition’s effects on performance, $b = 0.38, SE_b = 0.50, t(115) = 0.77, p = .45, \Delta R^2 = .01, f^2 = .01, 95\% CI [-0.61, 1.37]$.

Additional analyses

Subjective performance

Six outliers were removed, leaving 118 participants. Hayes’ (2012) Model 1 was used to analyze religiosity as a moderator of prayer’s effects on performance bias (perceived performance relative to peers, as a percentile – actual performance relative to peers, as a percentile). The model was not significant, $F(3, 114) = 0.65, p = .58, R^2 = .02$. Condition did not affect performance, $b = 0.10, SE_b = 0.10, t(114) = .10, p = .32, 95\% CI [-0.10, 0.30]$. Religiosity did not predict performance bias, $b = 0.02, SE_b = 0.12, t(114) = 0.15, p = .89, 95\% CI [-0.21, 0.24]$. Religiosity did not moderate prayer’s effects on performance bias, $b = -0.01, SE_b = 0.04, t(114) = -0.33, p = .75, \Delta R^2 < .01, f^2 < .01, 95\% CI [-0.10, 0.07]$.

Perceptions of anagram ease

Four outliers were excluded that were excessively influencing the results, leaving 120 participants. Hayes’ (2012) Model 1 was used to test religiosity as a moderator of prayer’s effects on participants’ perceptions of anagram ease. The overall model was not significant, $F(3, 116) =$
1.49, \( p = .22, R^2 = .04 \). Condition did not account for the variability in perceptions of anagram ease, \( b = -0.15, SE_b = 0.22, t (116) = -0.67, p = .51, 95\% \text{ CI} [-0.58, 0.29] \). Religiosity was marginally predictive of participants’ perceptions of anagram ease, \( b = 0.40, SE_b = 0.24, t (116) = 1.66, p = 0.1, 95\% \text{ CI} [-0.08, 0.88] \). As seen in Figure 3.3., the interaction was marginally significant, such that prayer, relative to planning, increased perceptions of the anagram task’s ease as religiosity increased, \( b = -0.17, SE_b = 0.09, t (116) = -1.86, p = .07, \Delta R^2 = .03, f^2 = .03, 95\% \text{ CI} [-0.36, 0.01] \).

![Figure 3.3. Religiosity moderates prayer’s effects on perceptions of anagram ease](image)

(lower numbers indicate greater difficulty, higher numbers reflect greater ease).
Perceptions of writing task (prayer or planning) ease

Four outliers were excluded, leaving 120 participants for analysis. Hayes’ (2012) Model 1 was used to test religiosity as a moderator of prayer’s effects on participants’ perceptions of writing task ease (prayer or planning). The overall model was significant, $F(3, 116) = 22.27, p < .001, R^2 = .37$. Condition had a main effect on participants’ perceptions of writing ease, $b = 1.62$, $SE_b = 0.26$, $t(116) = 6.16, p < .001$, 95% CI [1.10, 2.14]. Religiosity predicted participants’ perceptions of writing ease, $b = 1.25$, $SE_b = 0.29$, $t(116) = 4.24, p < .001$, 95% CI [0.67, 1.83]. As seen in Figure 3.4., religiosity moderated the effects of condition on perceptions of writing task ease, $b = -0.43$, $SE_b = 0.11$, $t(116) = -3.78, p = .002$, $\Delta R^2 = .08$, $f^2 = .09$, 95% CI [-0.65, -0.20], with all but the very religious perceiving writing a prayer to be more difficult than writing their plans for the following day.

Figure 3.4. Religiosity moderates prayer’s effect on perceptions of writing ease (lower numbers indicate greater difficulty, higher numbers greater ease).
Moderated mediation of performance by perceptions of writing ease

Five outliers were excluded. Hayes’ (2012) Model 8 was used to analyze perceptions of writing ease (prayer or planning) as a mediator of prayer’s effects on participants’ performance, moderated by religiosity. Results indicated that perceptions of writing ease did not mediate condition’s effects (moderated by religiosity) on performance, \( b = 0.02, SE_{boot} = 0.09, 95\% \text{ CI}_{boot} [-0.15, 0.23] \).

Correlations

A strong, positive correlation was found between frequency of prayer and prayer experience. LOC: God did not correlate with LOC: Internal. Frequency of prayer did not correlate with LOC: Internal nor did prayer experience and LOC: Internal. Positive views about God did not correlate with LOC: Internal (see Table 3.4.)
Table 3.4.

*Pearson’s correlations among dependent measures.*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Persistence</td>
<td>.43*</td>
<td>.15</td>
<td>.19</td>
<td>.07</td>
<td>.07</td>
<td>-.15</td>
<td>-.05</td>
<td>-.16</td>
<td>-.20</td>
<td>.04</td>
<td>-.06</td>
<td></td>
</tr>
<tr>
<td>2. Performance</td>
<td>.03</td>
<td>.52*</td>
<td>.50*</td>
<td>.34</td>
<td>-.06</td>
<td>-.21</td>
<td>-.10</td>
<td>-.12</td>
<td>-.09</td>
<td>-.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Cond: Ease</td>
<td>.06</td>
<td>.02</td>
<td>.14</td>
<td>.18</td>
<td>.26</td>
<td>.19</td>
<td>.13</td>
<td>.05</td>
<td>.16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Subjective performance</td>
<td>.55*</td>
<td>.30*</td>
<td>&lt;.01</td>
<td>-.16</td>
<td>.02</td>
<td>.09</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Anagrams: Ease</td>
<td>.31*</td>
<td>-.04</td>
<td>.07</td>
<td>.10</td>
<td>.07</td>
<td>-.10</td>
<td>.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Internal attributions</td>
<td></td>
<td>-.12</td>
<td>-.05</td>
<td>-.05</td>
<td>.13</td>
<td>.09</td>
<td>-.05</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7. Religiosity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.64*</td>
<td>.76*</td>
<td>.28*</td>
<td>-.05</td>
<td>.83*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Prayer experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.78*</td>
<td>.30*</td>
<td>-.02</td>
<td>.77*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Frequency of prayer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.33*</td>
<td>-.09</td>
<td>.83*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Positive God views</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.12</td>
<td>.31*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. LOC: Internal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. LOC: God</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*p < .004* [Bonferroni corrected]
Discussion

Study 2 primarily aimed to replicate the findings from Study 1, using a paradigm in which participants could construct their own prayers (cf. Vandecreek et al., 2002). Results show that praying before the anagram task had similar effects, even when content was allowed to vary idiosyncratically: as in Study 1, prayer improved performance relative to control, as religiosity increased. Effects on affect and arousal, however, were not replicated. Self-generated prayers did not affect mood in the same way as reading prepared prayers whose content was unknown, putting accounts that rely on those processes (e.g., relaxation; social influence) into question. However, neither account can be ruled out, as mood and arousal were measured after the anagram task in both studies; it is possible that prayer influenced participants’ mood states earlier in the study.

Participants’ creation of their own prayers also offered the potential for additional insight into prayer content. Findings from Study 2 revealed that participants largely prayed petitionary prayers that asserted causal attributions: prayers in which they petitioned God for help with something (e.g., often anagrams, but also anxiety, or loved ones), as predicted and consistent with the literature. Participants frequently referenced achievement related words. All but one participant used words related to positive affective processes and nearly half wrote insight words, indicative of cognitive broadening and flexibility (Abe, 2009). However, use of insight words and positive emotion words did not correlate with religiosity, suggesting that these factors could not explain prayer’s differential effects. Indeed, analyses revealed no reliable differences in prayer content on the dimensions examined, as a function of religiosity. These results suggest that differences in prayer content cannot explain prayer’s differential effects on performance in the current studies, although it is possible that religious and nonreligious people would offer different prayers in other contexts.
The third aim of Study 2 was to explore an attributional account of the effects of prayer on performance. Intriguingly, the results revealed a pattern mimicking that on performance: religious participants who prayed not only performed better on the anagram task, but also reported stronger internal attributions of control. What’s more, those attributions mediated the effects of prayer on performance, consistent with the hypothesis that religious individuals, somewhat paradoxically, view attributions to God as an extension of their own control (Kay et al., 2010; Pyszczynski et al., 1999; Rothbaum et al., 1982; Spilka & Ladd, 2013). However, the opposite mediational path was also significant, consistent with the possibility that inferences of control were a consequence and not a cause of good performance. Experiment 3 attempt to disentangle these two causal paths.

The fourth aim of Study 2 was to explore positive views about God as a moderator of prayer’s effects on performance. Positive views about God did not moderate prayer’s effects on performance, suggesting that the benefits religious participants obtained from praying were not due to their distinctive (presumably positive) view of God relative to nonbelievers.

Additional analyses showed that praying slightly, but not significantly, affected the religious and non-religious participants’ perceptions of anagram ease. However, most participants, excluding the most religious, found writing a prayer more difficult than writing their plans for the following day. Though perhaps unsurprising, the result does argue against ego depletion account, in which participants performed better on anagrams because they had more cognitive resources following prayer than following planning, a conclusion backed up by the fact that writing task ease did not mediate the prayer x religiosity effect on performance.

In sum, the primary finding in Study 1 was replicated with a different manipulation of prayer, and a different control condition: once again, prayer improved performance on an anagram task, relative to a control condition, to the extent that participants held religious beliefs. A parallel
effect on internal attributions of control was also found, although its causal role in performance is ambiguous.

Attribution, of course, is not the only explanation for the results (self-regulation and attention, for example, are others), but before pursuing other mechanisms, Study 3 was designed to disambiguate whether attribution is sufficient to explain performance. The ambiguity is due to the fact that participants completed the anagram task before attributing their control, so it is unclear whether participants performed better because of the internal attributions that prayer afforded, or whether prayer produced better performance for other reasons, and participants merely attributed their success internally post hoc. Study 3, therefore, aimed to measure attributions before the anagram task began. If prayer directly produces internal attributions, Study 3 should replicate Study 2; if attributions are a downstream effect of performance, prayer should have no effect on attributions before participants have a chance to perform.
Chapter 4

Studies 3 & 4: Prayer and attributions of control

In two studies, using different experimental manipulations, religious participants who prayed performed better on an anagram test than those in control conditions, while nonreligious participants performed worse. Furthermore, in Study 2, prayer had parallel effects on attributions of internal control, raising the possibility that these attributions explained participants’ anagram success. However, mediation analyses were equivocal, and were consistent with internal attributions driving success, but also with participants attributing their success internally after the fact. Therefore, the primary goal of the studies in this chapter was to test the first causal path, by measuring attributions (explicitly in Study 3, implicitly in Study 4) in the absence of actual performance.

A second goal of Study 3 in particular was to explore perceptions of the experimental tasks, and the possibility that they could account for prayer effects. As discussed in Chapter 2, Ladd and colleagues (2015) suggested that prayer-on-demand experimental designs may lack validity, as prayer in the lab may not parallel prayer as typically practiced by petitioners. Thus, it is possible that religious and nonreligious participants had differential perceptions of the validity of the prayers they were reciting, and/or the likely effectiveness of those prayers for improving their performance. Alternatively, prayer may have affected performance by influencing participants’ expectations of the anagram task. Therefore, prayer’s effects, moderated by religiosity, on predictive perceptions of the anagram task (their performance and the anagram task’s ease) were explored. Nonreligious participants may have found prayer more difficult (or easy), in turn influencing their performance on a subsequent task. Indeed, Study 2 showed that all participants, excluding the highly religious, found writing a prayer more difficult than writing their plans for
the following day. However, these perceptions did not mediate prayer’s effects on performance, casting a doubt on an ego depletion hypothesis. Nonetheless, Study 3 includes a variety of measures of task difficulty and validity, and also includes an additional control in which participants complete no pre-anagram task at all.

Finally, Study 3 was conducted online via Amazon’s Mechanical Turk. Although the shift in populations risks some confounds, such as the change in the experimental environment (in the laboratory versus participants’ homes) or the change in population (New Zealand undergraduate sample versus U.S.A. nationally representative sample; Berinsky, Huber, & Lenz, 2012), MTURK provides a larger and more diverse sample for analysis.

Method

Participants

A power analysis based on the effect sizes for religiosity’s moderation of prayer’s effects on internal attributions of control ($f^2 = .03$) found in Study 2 using GPower (Faul et al., 1992) indicated 378 participants were needed to achieve statistical power (1 - $\beta$) of 0.80 when $\alpha = 0.05$, two-tailed. Three hundred and ninety-nine participants ($M_{age} = 35.51$, 154 males, 244 females, 1 “other”) were recruited from Amazon Mechanical Turk (MTurk) for a study on “beliefs and anagrams.” Two-hundred and fifty-three participants (63%) reported their identity as religious (81% of them as Christian).

Design and measures

Participants were randomly assigned to one of three conditions: Prayer, Planning, or Control. As in Study 2, attributions of control were measured on a modified version of the 9-item revised causal dimension scale (CDSII; McAuley et al., 1992; see Appendix C), modified to refer
predictions of attributions for performance on the anagram task, rather than past performance.

Religiosity was measured using a 6-item revised SBS scale (Jong & Halberstadt, 2016). The 6-item revised SBS scale has marginally weaker predictive validity, but is more adaptable for cross-cultural research, which is particularly relevant for an MTurk sample (Jong & Halberstadt, 2016).

Participants’ perceptions of writing task ease were measured as described in Study 2 (see Appendix E). Participants’ beliefs about the effectiveness of praying or planning as a performance enhancement for solving anagrams were measured (in those conditions only) on a 7-point Likert scale, anchored at “definitely not effective” and “definitely effective” (see Appendix E). Participants’ perceptions of the typicality of their prayers were measured with the question, “To what extent do you think your prayer reflects a typical prayer?” (Appendix E), to which they responded on a 7-point Likert scale, anchored at “very atypical” and “very typical.”

Because of the changes to procedure, and because cheating could not be monitored with this sample, participants were not given the full anagram task. However, to follow through with tasks participants were expecting, they were given the five easiest anagrams to solve. Participants were also asked to predict their performance on the five anagrams as the correct number of anagrams solved correctly out of 5 and relative to their peers as a percentile (see Appendix D). They were also asked to make predictions of the anagram task’s ease (before seeing the anagrams) on a 7-point Likert scale, anchored at very difficult and very easy, with higher scores reflecting perceptions of easiness and lower scores indicating perceptions of greater difficulty (see Appendix D).

Trait LOC, prayer behavior and experience, and views about God were measured as described in Study 2. A concentration check, consisting of a lengthy question with the “correct”
Procedure

Participants completed the study online, in a survey programmed in Qualtrics (Qualtrics, 2015). The procedure was the same as Studies 1 and 2 with the following changes: The anagram instructions slightly differed from the instructions used in Studies 1 and 2. Participants were told:

An “anagram” is a word whose letters have been mixed up. For example, the anagram “ATHEW” can be unscrambled to make the English word “WHEAT”. In this experiment, we will give you a set of anagrams and ask you to unscramble them to form English words.

Participants in the control condition went directly to the next task, while participants in the prayer and planning conditions were additionally given the same instructions as described in Study 2. Participants then made attributions for their anagram performance using the adapted CDSII, predicted their performance on the anagram task and the ease of the anagram task, and (in the prayer and planning conditions) rated the writing task’s ease. Finally, they completed the abridged anagram task, and were debriefed and thanked for their time.

Results

Eleven participants failed the concentration check and were excluded from all analyses, leaving 388 participants for analysis, unless indicated otherwise below. As in Studies 1 and 2, religiosity was mean centered for all regression analyses.

Attributions

Hayes’ (2012) Model 1 was used to test the effects of condition (prayer, planning, or
control, dummy coded), religiosity, and their interaction on state internal attributions of control, controlling for trait internal locus of control (eight participants with outlying values, as identified by Cook’s distance, were not included in this analysis). Conditions were dummy coded in the same way as described in Study 1. In D1, the prayer condition was dummy coded as 1 and the two control conditions as 0.

The overall model was not significant, $F(4, 376) = 0.26$, $p = .86$, $R^2 = .002$. D1 did not affect attributions of internal control, $b = -0.12$, $SE_b = 0.19$, $t(376) = -0.60$, $p = .55$, 95% CI [-0.50, 0.27]. Religiosity did not predict differences in attributions of internal control, $b = 0.01$, $SE_b = 0.04$, $t(376) = 0.18$, $p = .86$, 95% CI [-0.08, 0.09]. Religiosity did not moderate prayer’s null effects on attributions of internal control, $b = -0.04$, $SE_b = 0.07$, $t(376) = -0.62$, $p = .54$, $\Delta R^2 = .001$, $f^2 = .001$, 95% CI [-0.18, 0.10].

A second analysis examined the equivalence of the planning and control conditions. In D2, the planning condition was dummy coded as 1 and the control condition as 0. The overall model was not significant, $F(4, 261) = 1.27$, $p = .28$, $R^2 = .02$. D2 did not affect internal attributions of control, $b = -0.34$, $SE_b = .22$, $t(256) = -1.54$, $p = .13$, 95% CI [-0.78, 0.10]. Religiosity did not predict internal attributions of control, $b = -0.003$, $SE_b = 0.07$, $t(256) = -0.05$, $p = .96$, 95% CI [-0.15, 0.14]. Religiosity did not moderate D2’s null effects, $b = -0.09$, $SE_b = 0.09$, $t(256) = -1.06$, $p = .29$, $\Delta R^2 = .004$, $f^2 = .004$, 95% CI [-0.26, 0.08].

**Perceptions of prayer’s effectiveness**

The same analysis was used to test the effects of condition (prayer or planning), religiosity, and their interaction on perceptions of effectiveness of the writing task ($n = 256$). Six participants with outlying values were not included in this analysis, leaving 250 participants (Cook, 1977). The overall model was significant, $F(3, 246) = 20.81$, $p < .001$, $R^2 = .20$. Condition did not
influence perceptions of effectiveness, $b = -0.03$, $SE_b = 0.12$, $t(246) = -0.27$, $p = .79$, 95% CI [-0.27, 0.20]. Religiosity predicted perceptions of writing task effectiveness, $b = 0.44$, $SE_b = 0.07$, $t(246) = 6.28$, $p < .001$, 95% CI [0.30, 0.58], and condition moderated its effect, $b = -0.20$, $SE_b = 0.05$, $t(246) = -4.40$, $p < .001$, $\Delta R^2 = .06$, $f^2 = .07$, 95% CI [-0.29, -0.12]. As seen in Figure 4.1, as religiosity increased, participants’ perceptions of prayer’s effectiveness increased.

![Figure 4.1. Religiosity moderates perceptions of cond. effectiveness.](image)

**Predictions about anagram ease**

The same analysis was used to test the effects of condition (prayer, planning, or control, dummy coded), religiosity, and their interaction on predictions about anagram ease. Six outliers were excluded, leaving 382 participants. Conditions were dummy coded in the same way as described above and in Study 1. In D1, the prayer condition was dummy coded as 1 and the two control conditions as 0.
The overall model was marginally significant, $F (3, 378) = 2.54, p = .06, R^2 = .02$. D1 did not account for the variability in predictions about anagram ease, $b = -0.12, SE_b = 0.15, t (378) = 0.82, p = .41$, 95% CI [-0.17, 0.42]. Religiosity did not predict participants’ predictions about anagram ease, $b = -0.02, SE_b = 0.03, t (378) = -0.47, p = .64$, 95% CI [-0.08, 0.05]. The interaction was marginally significant, $b = -0.10, SE_b = 0.06, t (378) = -1.77, p = .08$, 95% CI [-0.21, 0.01]. As seen in Figure 4.2, the interaction is due to prayer increasing perceptions of ease, relative to control conditions, as religiosity decreases.

The equivalency of the control conditions (planning and control) was examined in the same way as described above and in Study 1. In D2, the planning condition was dummy coded as 1 and the control condition as 0. The overall model was not significant, $F (3, 256) = 0.38, p = .77, R^2 = .004$. D2 did not affect predictions about the anagrams’ ease, $b = -0.15, SE_b = .17, t (256) = -0.89, p = .37$, 95% CI [-0.49, 0.19]. Religiosity did not predict predictions about the anagram task’s ease, $b = -0.01, SE_b = 0.05, t (256) = -0.12, p = .90$, 95% CI [-0.10, 0.08]. Religiosity did not moderate D2’s null effects, $b = -0.02, SE_b = 0.07, t (256) = -0.33, p = .74$, $\Delta R^2 < .001, f^2 < .001$, 95% CI [-0.15, 0.12].
Subjective performance

Predictions about performance, as a percentile compared to one’s peers, and as an estimate of how many anagrams (out of five) that would be solved correctly, were highly correlated ($\rho = .66$, $p < .001$) and the two were multiplied to create a composite score. The composite score was non-normally distributed, with skewness of 18.34 ($SE = 0.13$) and kurtosis of 340.54 ($SE = 0.26$), so the composite score was standardized (i.e., $z$ scores) before analysis. The same analysis was used to test the effects of condition (prayer, planning, or control, dummy coded), religiosity, and their interaction on predictions about anagram performance. Cook’s distance identified four outliers, leaving 384.

The overall model was marginally significant, $F (3, 380) = 2.23, p = .09, R^2 = .02$. D1 did
not account for the variance in predictions about performance, \( b = 0.06, SE_b = 0.06, t (380) = 1.00, p = .32, 95\% CI [-0.06, 0.18] \). Religiosity did not predict participants’ predictions about their performance, \( b = 0.01, SE_b = 0.01, t (380) = 0.54, p = .59, 95\% CI [-0.02, 0.03] \). The interaction was significant, \( b = -0.05, SE_b = 0.02, t (380) = -2.16, p = .03, 95\% CI [-0.09, -0.004] \). As seen in Figure 4.3, the interaction is due to more pessimistic predictions about performance following prayer (relative to control conditions), as religiosity increased.

The same analysis examined the equivalence of the control conditions (planning and control). The overall model was not significant, \( F (3, 257) = 0.98, p = .40, R^2 = .01 \). The control conditions did not significantly differ, \( b = -0.11, SE_b = .02, t (257) = 0.07, p = .12, 95\% CI [-0.24, 0.03] \). Religiosity did not predict predictions about anagram performance, \( b = 0.01, SE_b = 0.02, t (257) = 0.64, p = .52, 95\% CI [-0.02, 0.05] \). Religiosity did not moderate D2’s null effects, \( b = -0.01, SE_b = 0.03, t (257) = -0.37, p = .71, \Delta R^2 = .001, f^2 = .001, 95\% CI [-0.06, 0.04] \).
Prayer’s typicality

About half of participants in the prayer condition (54%) considered their prayers to be typical of real prayers (“somewhat typical” or “very typical”). About a third of participants (32%) rated their prayers as somewhat atypical or very atypical (32%), and 14% participants perceiving their prayers as neither typical nor atypical.

Additional analyses

SBS comparisons

An independent-samples t-test was conducted to compare SBS scores in this MTurk sample (Study 3) with the NZ samples (Studies 1 and 2). There was a significant difference in supernatural
belief scores in the MTurk (U.S.A.) sample ($M = 0.78$, $SD = 2.68$) compared to the New Zealand undergraduate sample ($M = -0.65$, $SD = 2.40$), $t(592) = -6.34$, $p < .001$, with MTurkers endorsing more supernatural beliefs than New Zealand undergraduates.

**Correlations**

Correlations among all dependent measures appear in Table 4.1, As seen in the table, strong and substantial correlations were found between praying behavior (frequency of prayer and prayer experience) and an internal LOC. Participants who prayed more frequently demonstrated a higher internal LOC compared to participants who prayed less frequently. Participants who reported a more positive prayer experience also showed a higher internal LOC, compared to participants who had a less positive prayer experience. Correlation analysis in Study 3 revealed robust and positive correlations between positive views about God, LOC: Internal, and LOC: God.

In addition, Pearson’s correlations revealed positive correlations between perceptions of prayer’s typicality, frequency of prayer, and religiosity, showing that as religiosity and frequency of prayer increased, perceptions of prayer’s typicality also increased. However, following a Bonferroni correction, the correlations were not statistically significant.
Table 4.1.
*Pearson’s correlations among dependent measures.*

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<td>1. Internal attributions</td>
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<td>.01</td>
<td>.03</td>
<td>.15*</td>
<td>.16*</td>
<td>-.02</td>
<td>&lt;</td>
<td>-.07</td>
<td>.08</td>
<td>.04</td>
<td>-.11</td>
<td>.01</td>
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<td>2. Cond: Ease</td>
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<td>.16</td>
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<td>.01</td>
<td>.18</td>
<td>.27*</td>
<td>.21*</td>
<td>.22*</td>
<td>.21*</td>
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<td>3. Cond: Effectiveness</td>
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<td>4. Prayer typicality</td>
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<td>.02</td>
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<td>5. Performance predictions</td>
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<td>-.05</td>
<td>&lt;.01</td>
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<td>.04</td>
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<td>6. Anagrams: Ease</td>
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<td>-.08</td>
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<td>7. Religiosity (SBS)</td>
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<td>.63*</td>
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<td>8. Prayer experience</td>
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<td>9. Prayer freq.</td>
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<td>.45**</td>
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<td>10. Positive God views</td>
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<td>11. LOC: Internal</td>
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<td>12. LOC: God</td>
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*p < .004 * [Bonferroni corrected]
Discussion

Although Study 2 found parallel effects of prayer on anagram performance and on internal attributions, it was not clear whether the latter was a cause or a consequence of the former. Prayer may have increased attributions of internal control, which improved performance, or alternatively may have increased performance for other reasons, and performance was attributed after the fact. The primary aim of Study 3 was to investigate one causal path by testing internal attributions of control in the absence of the anagram task. Results show that praying does not directly affect attributions of internal control, suggesting that prayer’s effect in Study 2 cannot be accounted for by this factor.

The secondary aim of Study 3 was to examine prayer’s effects on perceptions of the tasks. Ladd and colleagues (2015) proposed that prayer in the lab may not mirror prayer in the natural world. Participants’ perceptions of the validity of their prayers, or their prayer’s effectiveness, may depend on their religious beliefs and these perceptions could account for prayer’s effects. Indeed, as religiosity increased, participants believed writing a prayer to be a more effective performance enhancer, compared to those in the control conditions. However, participants’ perceptions of prayer’s effectiveness did not translate to predicted performance. In addition, while nonbelievers who prayed predicted that the anagram task would be easier than nonbelievers who planned, believers who prayed did not predict that the anagram task would be more difficult. Together, these results call into question an account of prayer based solely on different expectations by religious and nonreligious participants.

About half of participants considered their prayers to be typical and religiosity and frequency of prayer positively, although not significantly, correlated with perceptions of prayer’s typicality. These results suggest, somewhat counterintuitively, that practiced petitioners see
prayer-on-demand manipulation as not greatly dissimilar to the prayers they offer outside the laboratory. In Study 4, the replicability of these results was examined.

Although not its primary aim, Study 3 permitted another look at the correlational relationships among prayer experience, locus of control, and views about God. Some of the findings in Studies 1 and 2 were replicated: for example, participants who prayed more frequently and reported a more positive prayer experience also had more positive views about God and a higher God LOC. However, unlike in the previous studies (though consistent with other literature), Study 3 revealed strong and positive correlations between praying behavior and God LOC and internal LOC. Results also suggested robust and positive correlations between positive views about God and both a stronger internal and a God LOC. Participants who demonstrated a greater God LOC also showed a higher internal LOC.

It is unclear what accounts for differences between the New Zealand and American samples, but Kay, Shepherd, Blatz, Chua, and Galinsky (2010) offer one possibility. Kay et al. found a hydraulic relationship between trust in God and trust in government. When they experimentally lowered faith in external systems such as government, they found a subsequent increase in faith in God, suggesting that people flexibly rely on external sources of control when feelings of personal control are decreased.

In 2016, New Zealand tied with Denmark as the least corrupt country in the world, in comparison to the United States, which ranked 18th (Transparency International, 2016). These indices take into account the public sector’s perceptions of corruption and can be used a proxy for trust in government. Furthermore, as seen in the results, the U.S. sample exhibited substantially more supernatural beliefs than the N.Z. sample, offering tangential evidence for the hydraulic relationship found by Kay and colleagues. One could speculate, then, that participants in the NZ
sample have less “need” for God as a source of external control, as society and government are sufficient.
Study 4: Prayer and implicit attributions of control

While the results from Study 3 show that praying does not directly affect explicit attributions of internal control, prayer, moderated by religiosity, could have affected participants’ implicit associations related to control, which in turn impacted their performance. Indeed, studies show that implicit activation of self-concepts regarding personal control and positive self-stereotypes increase cognitive performance (Gibson, Losee, & Vitiello, 2014; Levy, 1996; Shih, Pittinsky, & Ambady, 1999). Similarly, prayer could implicitly activate personal control associations. According to Koole, McCullough, Kuhl, and Roelofsma (2009), religion fosters an implicit self-regulatory mode that is flexible, intuitive, and productive for those who believe. According to Koole et al., religion, and particularly prayer, works via non-conscious processes to facilitate functioning through implicit self-concept, self-serving attributions, mood, and motivations. In this way, petitioners might temporarily associate more effective (or ineffective) traits with themselves, depending on their supernatural beliefs. Therefore, Study 4 aimed to examine the potential for prayer to affect implicit associations between the self and internal attributions of control at varying levels of religiosity.

Method

Participants

The same power analysis computed for Study 3 was used for Study 4, but for one less condition, as planning was removed as a control. The power analysis indicated that 325 participants were needed to achieve statistical power (1 - β) of 0.80 when α = 0.05, two-tailed. Three

25 The replicability of these effects is inconsistent. While some replications have confirmed an effect of implicit positive self-stereotypes on cognitive performance (e.g., Gibson et al., 2014), at least one has not (Moon & Roeder, 2014).
hundred and fifty participants were recruited from Amazon Mechanical Turk (MTurk) for a study on beliefs and personality. Participants living in the United States participated in exchange for US $0.40. Forty-one participants reported using a phone or tablet and therefore did not meet the requirement of working from a desktop or laptop computer. Of the remaining 309 participants, 189 were female, 117 were male, and three reported their gender as “other.” Participants ages ranged from 18 to 72 (Mage: 36). One hundred and ninety-six participants (63%) identified as religious (81% of them Christian).

**Design and measures**

Participants were randomly assigned to one of two conditions: Prayer or Control. As seen in the screen image, Figures 4.4. and 4.5., implicit associations of control were measured via a single category implicit association test (SC - IAT), developed and designed on Qualtrics using JavaScript (Karpinski & Steinman, 2006). The SC - IAT was designed to measure cognitive associations between words related to the self (I, me, my, mine, self, & myself), internal control-congruent words (capable, empowered, assertive, in control, influential, & effective), and internal control-incongruent words (influenced, helpless, powerless, ineffective, dependent, & incapable), following the design structure of Karpinski and Steinman (2006). In each of the two stages, participants categorized as quickly and accurately as possible target words with the self. Qualtrics recorded response times in milliseconds and notified participants of errors. The six congruent words and incongruent words were matched on mean number of letters. Each word was presented four times during each stage, in a random order. Trials in which participants responded too slowly (> 10,000 ms) or too quickly (< 300 ms) were excluded. Response times were standardized for each trial and then averaged for each stage. The standardized difference (D) in response time between stage 1 and stage 2 was calculated, representing the speed at which participants associated
me with internal control congruent words compared to internal control incongruent words.

<table>
<thead>
<tr>
<th>Empowered</th>
<th>Powerless</th>
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<tr>
<td>or Me</td>
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</table>

Please read these instructions carefully, because the responses have changed. There are now three categories of words: "Empowered", "Powerless", and "Me":

The Me words are: I, me, my, mine, self, myself

The Empowered words are still: capable, empowered, assertive, in control, influential, effective

The Powerless words are still: influenced, helpless, powerless, ineffective, dependent, incapable

Your task is now to categorize the Empowered and Me words by pressing the "Z" key, and the Powerless words by pressing the "M" key.

Please respond to all the items as quickly and as accurately as possible. Now, rest your index fingers on the "Z" and "M" keys respectively, and press the [CTRL/Control] key to begin the task.

*Figure 4.4. Computer screen image of the SC – IAT stage 1 instructions.*
Religiosity was measured using the 6-item revised SBS scale used in Study 3. As in Studies 2, 3, and 4, participants’ perceptions of ease for writing a prayer were measured (see Appendix E). Participants’ beliefs about the effectiveness of writing a prayer and its typicality were measured in the same way as in Studies 3 and 4 (see Appendix E). Trait LOC, prayer behavior and experience, and views about God were measured as described in Studies 1 and 2.

Procedure

Participants completed the study online, via Qualtrics, LLC (2016). The procedure was the same as described in Studies 1, 2, and 3 excluding the following changes: The manipulation was altered to reflect a cognitive test, rather than an anagram task. Participants were told:
In the next part of the study you will be taking part in a cognitive test, in which you identify words and group them into categories as quickly as possible.  

[Control: Press “Next” to begin.]

Participants in the prayer condition were additionally told:

Research suggests that writing a prayer, even if you don’t believe in God, can improve performance on such tasks. Therefore, we will ask you to write a prayer before the test. Try to spend at least five minutes writing your prayer. Press “Next” when you are finished.  

After the manipulation, participants completed the ST - IAT. Participants rated their perceptions of the prayer’s ease, the prayer’s typicality, and the prayer’s effectiveness before completing the shortened anagram task (5 anagrams). Participants were debriefed and thanked for their time.

Results

Ten participants failed the concentration check, leaving 299 participants for analysis unless otherwise stated.  

Implicit associations of control

Hayes’ (2012) Model 1 was used to test the effects of condition (prayer or control), religiosity, and their interaction on implicit associations of control, as measured by the standardized speed at which participants associated self-related words with internal control congruent words compared to internal control incongruent words. Fourteen outliers were removed as identified by Cook’s distance, leaving 285 participants.
The overall model was not significant, $F(3, 281) = 0.09, p = .97, R^2 = .001$. Condition did not account for the variability in time, $b = -0.003, SE_b = 0.03, t(281) = -0.10, p = .92, 95\% CI [-0.05, 0.05]$. Religiosity did not predict participants’ time difference, $b = 0.003, SE_b = 0.01, t(281) = 0.49, p = .63, 95\% CI [-0.01, 0.02]$. The interaction did not affect differences in time, $b = -0.002, SE_b = 0.01, t(281) = -0.25, p = .81, 95\% CI [-0.02, 0.02], \Delta R^2 < .001, f^2 < .001$.

Additional analyses

SBS comparisons

As in Study 3, an independent-samples t-test was conducted to compare SBS scores in the MTurk samples (Studies 3 & 4) with the NZ samples (Studies 1 & 2). There was a significant difference in supernatural belief scores in the MTurk (U.S.A.) samples ($M = 0.94, SD = 2.67$) compared to the New Zealand undergraduate sample ($M = -0.65, SD = 2.40$), $t(887) = -6.34, p < .001$, with Americans holding more supernatural beliefs than New Zealand undergraduates.

Prayer’s typicality

About half of participants (54\%) rated their prayer to be a typical prayer to very typical prayer. Almost a third of participants considered their prayer to represent a somewhat atypical to very atypical prayer (28\%) and 18\% rated their prayer as neither typical nor atypical.

Correlations

Correlations between perceptions of the experimental tasks were investigated as seen in Table 4.2. Correlations between the perceptions of condition’s typicality and religiosity and frequency of prayer showed that as religiosity and frequency of prayer increased, perceptions about the typicality of prayer also increased. Pearson’s correlations revealed substantial correlations...
between frequency of prayer, prayer experience, internal LOC, and God LOC.

Table 4.2.

*Pearson’s correlations of dependent measures.*

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<td>.56**</td>
<td>.32**</td>
<td>.34**</td>
<td>.04</td>
<td>.39**</td>
<td>.27**</td>
<td>.58**</td>
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<td>&lt;.01</td>
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<td>.75**</td>
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<td>.44**</td>
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<td>5. Prayer: Effectiveness</td>
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<td>.53**</td>
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<td>6. Associations of control</td>
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<td>7. Prayer experience</td>
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<td>8. Positive God views</td>
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<td>9. LOC: Internal</td>
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*p < .005*, *p < .001** [Bonferroni corrected]
Discussion

Although there was no evidence for attributional effects as a result of prayer, regardless of religiosity, it is possible that such effects are implicit, or even nonconscious, and that petitioners, especially religious ones, temporarily associate more effective traits with themselves. However, the results from Study 4, which assessed these cognitive associations, revealed no evidence of such implicit effects. Although the results of Study 4 in particular should be interpreted with caution, given that the implicit measure used has not been validated for measuring control attributions, the results from Studies 3 and 4 offer no support for the attributional interpretation of Studies 1 and 2.

Study 4 also provided a new opportunity to consider the perceived typicality of prayer. In Study 3, results showed that about half of participants considered their prayers to be typical, and that religiosity and frequency of prayer marginally, but not significantly correlated with perceptions of prayer’s typicality. Study 4 replicated these results and found larger in magnitude, positive correlations between perceptions of prayer’s typicality and religiosity and frequency of prayer. Practiced petitioners see the prayer-on-demand experimental manipulation as reflective of their typical prayers in their natural environments. Together, the results from Studies 3 and 4 provide loose support for the validity of the manipulation.

Finally, Study 4 provided further, exploratory correlational data on the relationship between praying behavior, views about God, and LOC. Correlational analyses in Study 4 replicated the correlations found in Study 3 and diverged in the same way from Studies 1 and 2. Consistent with Study 4, but inconsistent with Studies 1 and 2, participants who prayed more frequently and reported a more positive prayer experience demonstrated a higher internal LOC, compared to participants who prayed less frequently and had a less positive prayer experience. In addition, participants who perceived God more positively demonstrated both a higher internal LOC
and a God LOC. A high internal LOC was strongly correlated with a high God LOC.
Chapter 5

Study 5: Prayer and self-control

The data in Studies 1 and 2 revealed an interaction between prayer and religious belief on cognitive performance: relative to controls, believers who prayed answered more anagrams correctly, but nonbelievers who prayed answered fewer. Study 2 also offered one possible explanation for the effect, that religious believers felt more in control over their performance. However, the results of Studies 3 and 4, which tested for attributions of control in the absence of performance, were not consistent with this account. Results from Study 3 also provided initial evidence for an expectation account of prayer, with believers differing in their perceptions of prayer’s effectiveness compared to nonbelievers. However, despite finding prayer more effective as a performance enhancer, believers did not predict that they would perform better on the anagram task nor did they expect the anagram task to be more difficult. Together, these results cast a doubt on an expectancy account of prayer.

As discussed in Chapter 1, another possible mechanism of prayer’s effects on performance is self-control or, relatedly, attentional capacity. Self-control, the effortful practice of self-regulation (Baumeister & Tierny, 2011), is conceptually distinct from attributions of control (Ramezani & Gholrash, 2015), which refer to perceptions of controllability (Weiner, 1985). In theory, prayer could enhance self-control by stimulating motivation to complete the task, by reminding participants of their standards and ideals, and/or by enhancing accountability (in the case of theists) to the supernatural entity to whom they direct their prayers. Indeed, prayer appears to increase self-control and attention capacity. Friese and colleagues (2014a; 2014b) found that prayer buffered the effects of self-control depletion (caused by thought suppression) on Stroop performance, regardless of participants’ religiosity. Adams and colleagues (2016) found similar
effects of prayer on Stroop performance and a visual search task, but only for the highly religious. In a second study, Adams et al., (2016) found that prayer increased word response times on a lexical-decision task and performance on a word-search task for all participants, although significantly more for the highly religious.

The primary goal of Study 5 was to examine the effects of prayer and religiosity on self-control, specifically delayed gratification, using a temporal discounting measure. Temporal discounting, also known as delay discounting or time discounting, refers to people’s tendency to discount rewards as they become more distant in time (Madden & Bickel, 2010). People generally prefer smaller immediate rewards to larger but delayed rewards. For instance, people typically prefer to receive $5 today than $10 in a month (Story, Vlaev, Seymour, Darzi, Dolan, 2014). The lesser immediate reward is termed the impulsive choice, while the greater delayed reward is referred to as the self-controlled choice (Ainslie, 1974). Temporal discounting measures are frequently used in behavioral economics, social psychology, and the cognitive sciences, particularly as a self-regulation measurement of impulsivity and delayed gratification. A substantial body of literature connects temporal discounting failures with addiction (Bickel & Marsch, 2001; MacKillop et al., 2011), obesity (Lim & Bruce, 2015), and sexual risk-taking (Lawyer, Williams, Prihodova, Rollins, & Lester, 2010).

Evidence of the relationship between temporal discounting and religion is inconsistent, however. Carter, McCullough, Kim-Spoon, Corrales, and Blake (2012) found that religious commitment was correlated with temporal discounting and that future time orientation (perceived proximity of the future; “the future is fast approaching”) mediated the effect. Roundling, Lee, Jacobson, and Ji (2012) found that implicit religious primes increased the ability to delay gratification, as measured by whether participants chose to receive $5 compensation for
experimental participation the following day or $6 the following week. However, Harrison and McKay (2013) proposed an alternative mechanism by which religious primes influenced temporal discounting: by increasing the relative importance of social motivations over financial incentives (i.e., the social signaling model of religion and supernatural monitoring hypothesis), consistent with the supernatural monitoring and social influence account described in Chapter 1.\textsuperscript{26} Consistent with this interpretation, Harrison and McKay (2013) failed to replicate Roundling and colleagues’ findings when the socially desirable option was unclear (i.e., in the context of an auction).\textsuperscript{27} Study 5 includes a measure of social desirable responding to account for this mechanism.

\section*{Method}

\subsection*{Participants}

A power analysis based on the effect sizes found in Study 2, on prayer’s effects on internal attributions of control \((f^2 = .03)\), was computed using GPower (Faul et al., 1992). GPower indicated that 325 participants were needed to achieve statistical power of 0.80 when \(\alpha = .05\), two-tailed. Allowing for unusable participants, I recruited 350 participants from Amazon’s Mechanical Turk (MTurk) for a study on “beliefs and cognitive performance,” in exchange for token payment of US$40. Of those, 27 reported using a phone or tablet and so did not meet the requirement of working from a desktop or laptop computer, leaving 324 in the final sample \((M_{age} = 35.73, 130

\textsuperscript{26} The social signaling model of religion proposes that religious adherents signal their social value and commitment by engaging in costly (prosocial) religious practices in order to benefit from social inclusion (Levy & Razin, 2014). The supernatural monitoring hypothesis proposes the imagined presence of a supernatural watcher elicits the prioritization of social presentation (Shariff & Norenzayan, 2007).

\textsuperscript{27} The auction involved asking participants to bid their own money (out of $30), “to break even”, for $9.90 or $29.90 investment returns on their bids at varying time delays. Participants could choose to keep their money, wait for delayed money, or concur that the options felt the same to them (Harrison & McKay, 2013).
males, 193 females, 1 “other”). Two-hundred and thirty-two (72%) participants reported their identity as religious (69% of them Christian).

**Design and measures**

Participants were randomly assigned to one of two conditions: Prayer or Control. Temporal discounting was measured using the extensively validated and commonly used 27-item Monetary Choice Questionnaire (MCQ; Kirby, Petry, & Bickel, 1999). On each item, participants chose between immediate, smaller rewards and delayed, larger rewards of differing magnitudes (9 small rewards, 9 medium, and 9 large; e.g., Would you prefer $55 today, or $75 in 61 days). Discounting rates for each level were calculated using Mazur’s (1987) and Kirby and colleagues’ (1999) hyperbolic discounting equation:

\[ V = \frac{A}{1 + kD}, \]

where \( V \) is the present value of the delayed reward, \( A \) is the amount of the delayed reward, \( D \) is the delay, and \( k \) is the individual discounting rate (Kirby & Marakovic, 1996). The discounting rate \( (k) \) represents the slope of the hyperbolic function, the individual’s value of delayed rewards, with larger \( k \) values reflecting larger delay discounting or simply, impulsivity. In other words, \( k \) describes the degree to which a monetary value is devalued by time. Hyperbolic \( k \) uniquely predicts reversals in preference as a function of time, consistent with theories of impulsivity and research with humans and non-humans (Kirby & Herrnstein, 1995; Green & Myerson, 2004; Mazur, 1987; Rachlin, 2006). Immediate choice ratios (ICR) were also calculated in order to provide a model-free discounting rate, by summing the immediate reward choices and dividing by

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28 The MCQ demonstrates good reliability and validity (Kirby et al., 1999); 1-year test-retest correlations range within the same levels as personality trait measures (Kirby, 2009). Comparisons in discounting rates between drug users and controls evidenced the MCQ’s construct validity (Kirby et al., 1999; Kirby & Petry, 2004).
the total number of choices for each level of rewards. Unlike the hyperbolic \( k \), immediate choice ratios do not depend on any theoretical assumptions.

Generally, human participants demonstrate lower time discount rates for larger rewards compared to smaller rewards (i.e., participants are more impatient with small rewards compared to large rewards), which is referred to as the magnitude effect (Kirby et al., 1996; Green & Myerson, 2004; Tan & Johnson, 1996; Du, Green, & Myerson, 2002). In three studies, Ballard, Kim, Liatsis, Aydogan, Cohen, & McClure (2017) demonstrated that the magnitude effect depends on self-control. First, Ballard and colleagues showed that lower rates of discounting for larger rewards correlated with self-control processes, indicated by increased activity in “frontal executive-control” brain areas.\(^{29}\) Second, the authors found that hunger, a self-control depletion manipulation, correlated inversely with the magnitude effect, with hungrier participants distinguishing less between small and large reward conditions. Third, the authors found that a self-control boosting manipulation reduced discounting. Together, these results suggest that the differences in the magnitude effect uniquely predict variability in self-control. Therefore, in Study 5, self-control was operationalized as differences in the magnitude effect across small and large rewards.

Social desirability was measured using the 33-item Marlowe-Crowne Social Desirability Scale (MCSDS; Crowne & Marlowe, 1960). The MCSDS is the most commonly used social desirability instrument and cited more than 8,000 times. Crowne and Marlowe (1960) demonstrated acceptable reliability and validity.\(^{30}\) Participants answer true or false to a series of 33 statements (e.g., I never hesitate to go out of my way to help someone in trouble). Relevant

\(^{29}\) Frontal executive-control brain areas correspond to self-control.

\(^{30}\) Internal consistency using the KR-20 was .88. Correlations with the MMPI scales and Edwards Social Desirability scale showed acceptable criterion-related validity.
items are reverse scored and summed to create a composite score, with higher numbers indicating greater motivation to respond in a socially desirable way.

Religiosity, perceptions of prayer’s ease, prayer’s effectiveness, prayer’s typicality, trait LOC, prayer behavior, and views of God were measured as described in Studies 1, 2, and 3. Five “easy” anagrams and a concentration check were used in the same way as in Studies 3 and 4.

Procedure

Participants completed the study online, via Qualtrics (Qualtrics, 2016). The procedure was the same as described in Studies 1, 2, 3, and 4. The manipulation (prayer versus control) was the same as described in Study 3. After the manipulation, all participants completed the MCQ, the MCSDS, and the five “easy” anagrams used in Studies 3 and 4. Participants who prayed rated the extent to which their prayer represented a typical prayer, how difficult they found writing a prayer, and the extent to which they thought praying would improve their performance on the cognitive test. Finally, all participants were debriefed and thanked for their time.

Results

Thirteen participants who failed the concentration check, and sixteen participants in the prayer condition who did not pray (as determined by a research assistant) were excluded from analyses, leaving 295 participants for analysis, unless indicated otherwise below. As in studies 1-4, religiosity was mean centered for all regression analyses.

Latent growth analysis

Gray, Amlung, Palmer, and MacKillop’s (2016) SPSS syntax was used to calculate hyperbolic $k$ and immediate choice ratios. The distribution of $k$ values was positively skewed, as is typical for this measure (Kirby et al., 1996, 1999; Green & Myerson, 2004; Gray et al., 2016),
and therefore log transformed (as recommended by previous researchers; Gray et al., 2016). Latent growth analysis (LGM) (Mirman, 2014; Preacher, Zyphur, & Zhang, 2010) was used to analyze the effects of prayer and religiosity on temporal discounting (hyperbolic k & ICR), controlling for socioeconomic status. Latent growth analysis was chosen because of its unique functionality in facilitating the use of a continuous moderator for multiple levels of a variable (e.g., small, medium, & large rewards). Competing models were tested in R (R Team, 2017), using the CRAN package, Lavaan (Rosseel, 2011). The code used can be found in Appendix G. Chi-square statistics, comparative fit index (CFI), root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) were used to assess model fit. The model comparisons and results can be found in Appendix H.

**Change between large and small discounting rates**

As seen in the latent growth models for hyperbolic k and immediate choice ratios (see Appendix H), the effect of temporal discounting is linear across small, medium, and large rewards, illustrating the magnitude effect. Condition did not directly affect the mean value of linear slopes.

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31 Latent growth analysis (LGM) is a multilevel regression technique and application of structural equation modeling (SEM). LGM provides the ability to assess model fits to data, change in latent variables (slope and intercept), and antecedents and sequels of change. Unlike repeated measures, LGM uniquely allows for continuous moderators. SEM (& LGM) have been criticized as “dangerously conjectural” (McDonald, 2013, p. 367). I take precautions by testing five latent growth models, assessing three model fit indices, and examining one theory driven hypothesis in two ways.

32 CFI, RMSEA, and SRMR are fit indices commonly used in SEM. The CFI measure of fit is a common model fit index (also referred to as an absolute fit index), that varies between 0 and 1, with values larger than 0.95 indicating a good fit (Hu & Bentler, 1999). The RMSEA measure of fit (also referred to as the “Ramsey”) is an absolute measure of fit and is the most commonly used measure of model fit with .01, .05, and .08 indicating excellent, good, and mediocre fit respectively (MacCallum, Browne, & Sugawara, 1996). The SRMR measure of fit is also an absolute measure of fit, with a value of 0 indicating a perfect fit and a value less than .08 being a good fit (Hu & Bentler, 1999).
(i.e., rate of change between levels). Religiosity did not predict the mean value of linear slopes, $b = -0.01, SE_b = 0.01, z (295) = -1.10, p = .27, 95\% CI [-0.02, 0.004]$. However, the mean value of linear slopes showed moderation of condition effects by religiosity (SBS score), controlling for socioeconomic status, $b = -0.01, SE_b = 0.01, z (295) = -2.05, p = 0.04, 95\% CI [-0.02, 0.00]$, showing that as religiosity increased, prayer decreased impulsivity for large relative to small rewards.

**Hyperbolic $k$**

In order to simplify the analyses and to reflect the rate of change, a difference score was calculated by subtracting the small discounting rate by the large discounting rate for both hyperbolic $k$ and immediate choice ratios. Hayes’ (2012) Model 1 was used to analyze the effects of condition, religiosity, and their interaction on the difference of the log transformed small and large hyperbolic $k$ values. Cook’s distance revealed six outliers that were significantly altering the model, leaving 289 participants.

The overall model was marginally significant, $F (3, 285) = 2.62, p = .05, R^2 = .03$. Condition did not influence the rate of change in discounting, $b = 0.03, SE_b = 0.02, t (285) = 1.29, p = .20, 95\% CI [-0.02, 0.08]$. Religiosity did not predict discounting changes, $b = -0.01, SE_b = 0.01, t (285) = -1.53, p = .13, 95\% CI [-0.03, 0.00]$. The interaction was significant, $b = -0.02, SE_b = 0.01, t (285) = -2.13, p = .03, 95\% CI [-0.04, -0.00], \Delta R^2 = .02, f^2 = .02$. As seen in Figure 5.1., the interaction is due to prayer, relative to control, decreasing the magnitude effect (the change in discounting from small to large magnitudes) as religiosity decreased.
Figure 5.1. Religiosity moderates prayer’s effect on discounting between small and large rewards as measured by hyperbolic k.

**Immediate choice ratios (ICR)**

The same analysis was used to analyze the effects of condition, religiosity, and their interaction on the difference of the small and large ICR. Five outliers were removed, leaving 290 participants (Cook, 1977).

The overall model was significant, $F(3, 286) = 3.13, p = .03, R^2 = .03$. Condition did not influence the rate of change in discounting, $b = 0.01, SE_b = 0.01, t(286) = 1.15, p = .25, 95\% \text{ CI} [-0.01, 0.02]$. Religiosity did not predict discounting changes, $b = -0.004, SE_b = 0.003, t(286) = -1.59, p = .11, 95\% \text{ CI} [-0.01, 0.001]$. The interaction was significant, $b = -0.01, SE_b = 0.002, t(286) = -2.52, p = .01, 95\% \text{ CI} [-0.01, -0.001], \Delta R^2 = .02, f^2 = .02$. As seen in Figure 5.3., the
interaction is due to prayer decreasing the magnitude effect as religiosity decreases, relative to the control.

![Image of Figure 5.3](image-url)

*Figure 5.3.* Religiosity moderates prayer’s effect on the difference in discounting between small and large rewards as measured by immediate choice ratios.

**Socially desirable responding**

The same analysis was used to test the effects of condition (prayer or control), religiosity, and their interaction on socially desirable responding, as measured by the Marlowe-Crowne Social Desirability Scale. Seven outliers were removed, leaving 288 participants for analysis (Cook, 1977).

The overall model was not significant, $F(3, 284) = 0.53, p = .67, R^2 = .01$. Condition did not account for the variability in socially desirable responding, $b = -0.27, SE_b = 0.31, t(284) = -0.89, p = .37, 95\%\ CI [-0.88, 0.33]$. Religiosity did not predict participants’ socially desirable
responding, $b = 0.09, SE_b = 0.12, t (284) = 0.71, p = .48$, 95% CI [-.15, .32]. The interaction was not significant, $b = -0.06, SE_b = 0.12, t (284) = -0.51, p = .61$, 95% CI [-.30, .18], $\Delta R^2 < .001, f^2 < .001$.

**Additional analyses**

**SBS comparisons**

As in Studies 3 and 4, an independent-samples t-test was compared SBS scores between the MTurk samples (Studies 3, 4, & 5) and the NZ samples (Studies 1 & 2). MTurkers ($M = 0.97$, $SD = 2.65$) endorsed significantly more supernatural beliefs than New Zealand undergraduates ($M = -0.65$, $SD = 2.40$), $t (1182) = -8.07, p < .001$.

**Prayer’s typicality**

More than half of participants (61%) considered their prayers to reflect a “somewhat” or “very” typical prayer. About a third (32%) of participants rated their prayers as “somewhat” or “very” atypical, and 7% participants reported perceiving their prayer as neither typical nor atypical.

**Correlations**

Correlations among all dependent measures appear in Table 5.1. As seen in the table, hyperbolic $k$ and immediate choice ratios were highly correlated. Participants who rated their prayers as more typical found writing a prayer easier and more effective in increasing their anagram performance, than participants who rated their prayers as less typical. Perceptions of prayer’s typicality, ease, and effectiveness did not correlate with socially desirable responding or the rate of change in temporal discounting. Correlations between perceptions of prayer’s typicality and religiosity and frequency of prayer revealed that greater religiosity and frequency of prayer
predicted increased perceptions of prayer’s typicality.

Table 5.1.

Pearson’s correlations among dependent measures.

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<td>4. Prayer: Ease</td>
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<td>5. Prayer: Effectiveness</td>
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<td>6. Prayer: Typicality</td>
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<td>8. Prayer experience</td>
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<td>9. Prayer freq.</td>
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*p < .004, p < .001** [Bonferroni corrected]
Discussion

The primary aim of Study 5 was to explore prayer’s effects on self-control in order to evaluate another mechanism by which prayer might have produced the pattern of anagram performance observed in Studies 1 and 2. Results from the latent growth analysis indicate that praying decreased impulsivity for believers across small, medium, and large rewards (as measured by hyperbolic $k$ and immediate choice ratios), increasing the magnitude effect. In other words, believers who prayed were better able to delay gratification for larger rewards than for smaller rewards compared to nonbelievers. The linear slopes showed that the hyperbolic $k$ and immediate choice ratios did not provide substantially different results. Results from the moderation analysis of the difference between large and small rewards were consistent with the results from the latent growth analysis, with praying considerably diminishing the magnitude effect as religiosity decreased, compared to the control condition. Together, the results suggest that both self-control and attention resources could be one of several mechanisms by which prayer affected performance differently in Studies 1 and 2.

Study 5 also examined the possibility that prayer affects self-control via perceived supernatural monitoring or social influence, operationalized as socially desirable responding. Results showed that praying did not affect socially desirable responding and socially desirable responding did not correlate with temporal discounting, putting a social influence or supernatural monitoring account into question. However, frequent prayers across both conditions were marginally more likely to respond in socially desirable ways, suggesting a relationship between social motivations and prayer.

Correlational analyses permitted an additional examination of participants’ perceptions of the experimental tasks. Perceptions of prayer’s typicality, ease, and effectiveness were highly
correlated, with participants who found their prayers to be more typical also rating their prayers easier to write and more effective in increasing their performance than participants who rated their prayers to be less typical. Consistent with Studies 3 and 4, as religiosity and frequency of prayer increased, perceptions of prayer’s typicality also increased. Combined, these results suggest that experienced prayers perceive the prayer manipulations used throughout this thesis as reflective of the prayers they typically pray, suggesting that “prayer on demand” manipulations in the laboratory should not be discounted as flawed or useless approximations of the “real thing.”

Additional exploratory correlations showed a divergence from the MTurk sample and convergence with the New Zealand undergraduate sample. Consistent with Studies 1 and 2 (NZ), however inconsistent with Studies 3 and 4 (U.S.A.), internal LOC did not correlate with praying behavior, views about God, or God LOC. These results do not support my previous speculation, as described in Study 3, that Americans might rely on God as a source of control more than New Zealanders, due to lack of trust in government.

**Summary of Studies 1-5**

In sum, results from Studies 1 and 2 revealed an interaction between prayer and religious belief on cognitive performance: relative to controls believers who prayed answered more anagrams correctly, but nonbelievers who prayed answered fewer. Study 1 provided one mechanism by which prayer may have influenced performance, that believers who prayed experienced heightened arousal and increased positive affect, but the effects were not replicated. Study 2 offered an alternative possibility, that believers attributed more control to themselves after prayer, but the results of Studies 3 and 4, which tested for attributions of control in the absence of performance, were not consistent with this account. Study 3 revealed yet another potential mechanism by which prayer influenced performance, that believers who prayed perceived the
prayer as more effective in improving their performance. However, perceptions of prayer’s effectiveness did not translate to predictions about performance, putting an expectancy account of prayer into question.

In Study 5, a self-control account was examined using a temporal discounting measure. Results show that prayer interacted with religiosity to affect temporal discounting rates, providing initial support for a self-control account of prayer that is partially consistent with the results found by Friese and colleagues (2014), who found that prayer replenished self-control after a self-control depletion task. Self-control may be one of several mechanisms by which prayer affected performance. In Study 6, the implications of prayer’s effects on self-control are examined in an important domain associated with self-control, cheating.
Chapter 6

Study 6: Prayer and cheating

In Study 5, prayer increased temporal discounting as religiosity increased, exacerbating the magnitude effect. In other words, prayer increased religious participants’ ability or willingness to subordinate their short-term desires for long-term rewards. Such an effect can not only explain prayer’s effects on performance in Studies 1 and 2, but also has implications for other domains in which immediate rewards must be resisted.

Cheating, conceptualized as dishonest behavior (Gino, Schweitzer, Mead, & Ariely, 2011; Mead, Baumeister, Gino, Schweitzer, & Ariely, 2009), is often treated as a problem of self-control, particularly in reference to temptation resistance, in that it requires resisting immediate rewards in favor of adherence to one’s standards or ideals (e.g., Gino et al., 2011; Mead et al., 2009). Indeed, low trait self-control predicts academic dishonesty (Cochran, Wood, Sellers, Wilkerson, & Chamlin, 1998) and cheating (Muraven, Pogarsky, & Shmueli, 2006). In multiple studies, experimentally manipulated self-control depletion increased cheating rates (Gino et al., 2012; Mead et al., 2009; Muraven et al., 2006).

Muraven and colleagues (2006), found that low trait self-control predicted cheating for financial gain. In addition, Muraven et al., (2006) found that experimentally depleted self-control increased cheating, even when controlling for low trait self-control. Mead and colleagues (2009) demonstrated a similar phenomenon to Muraven and colleagues (2006). In one study, Mead et al., (2009) found that self-control depletion increased cheating for financial gain. In a second study, Mead et al., (2009) found that participants depleted of self-control subjected themselves to the temptation to cheat and cheated more than participants who had not been depleted of self-control.

In two studies, Gino and colleagues (2011) found that self-control depletion increased
impulsive cheating for financial gain and reduced ethics awareness when faced with the temptation to cheat. In a third study, Gino and colleagues found that moral identity moderated the effects of self-control depletion on cheating, with participants having higher levels of moral identity being immune to the self-control depletion effects on cheating. In a fourth study, Gino et al., (2016) found that resisting the urge to cheat acted as a self-control depletion task, decreasing performance on the Stroop task (Stroop, 1935).

People typically assume that supernatural beliefs deter people from cheating (Gervais, Shariff, & Norenzayan, 2011). Those who lack supernatural beliefs (e.g., atheists) are among the least trusted and most disliked minority groups in the U.S.A. (Pew, 2017; Edgell, Hartmann, Stewart, Gerteis, 2016). Edgell and colleagues (2016) found that this distrust and dislike could be accounted for by moral and ethical concerns about atheists, whom participants associated with criminality, materialism, and lack of accountability (i.e., to a supernatural watcher). Gervais and colleagues (2011) found that prejudice against non-believers was motivated by distrust. Participants (including atheists themselves) associated atheism with criminality and untrustworthiness. The association was mediated by the perception that a belief in a supernatural watcher increases prosocial behavior.

In fact, the correlational evidence on religion’s relation to cheating is inconsistent, but no studies clearly support people’s intuitions that atheists cheat more than religious individuals. Most studies have not found any negative correlation between religiosity and cheating (Nowell & Laufer, 1997; Randolph-Seng & Nielsen, 2007; Shariff & Norenzayan, 2011; Sierles, Hendrickx, & Circle, 1980; Smith, Wheeler, & Diener, 1975) and some studies have found that religiosity predicts an increase in cheating (Guttman, 1984, Pruckner & Sausgriber, 2008).

Some experimental research suggests that religious belief might decrease cheating under
certain conditions (Norenzayan & Shariff, 2008). Implicit and explicit supernatural primes (e.g., ghosts, God) have been shown to decrease cheating and increase honesty, regardless of participants’ self-reported religiosity (Aveyard, 2014; Bering, McLeod, & Shackelford, 2005; Piazza, Bering, & Ingram, 2011; Randolph-Seng & Nielsen, 2007). Bering et al., (2005) and Piazza et al., (2011) found that supernatural primes decreased cheating. Bering et al., (2005) found that telling participants about the ghost of a dead graduate student (allegedly spotted previously in the experiment room) decreased cheating on a competitive computer task, compared to controls. Similarly, children told of the ghost of “Princess Alice” cheated significantly less than controls. When the researchers removed skeptical children from analysis, they found that being told about Princess Alice had the same inhibitory effect on cheating as having an adult in the same room. Aveyard (2014) demonstrated the generalizability of this phenomenon on Middle Eastern participants. Participants primed with religious content in a scrambled sentence task did not exhibit increased honesty, although participants primed with the Islamic call to prayer, were more honest than participants who were not primed.

Although there is no comparable study of cheating as a function of prayer, there are several reasons to predict that praying could reduce cheating, at least for religious participants. Most relevant in the current context, Study 5 revealed that prayer increases religious participants’ willingness to defer immediate gains for larger rewards than for smaller rewards compared to nonbelievers, which, as noted is a hallmark of self-control. This willingness itself may be due to multiple mechanisms, including priming of anti-cheating ideals combined with self- or supernatural-monitoring of them. Relatedly, Johnson and Krüger (2004) and Shariff and

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33 The supernatural monitoring hypothesis suggests that perceptions of God elicit the same effects as other social interactions, such as perceived social surveillance.
Norenzayan (2011) argue for the supernatural punishment hypothesis (SPH), a subsidiary of the supernatural monitoring hypothesis. Shariff et al., (2011) found that perceiving God as more punitive and less loving predicted lower cheating rates.

There are a number of paradigms for measuring cheating in the laboratory, some of them quite complex and themselves deceptive. For example, in one frequently used paradigm, participants solve math problems; they are warned that a computer glitch unintentionally displays the correct answer if they do not press the spacebar to stop it (von Hippel, Lakin, & Shakarchi, 2005). However, this task may not exclusively measure cheating, as it could also reflect slow response times or attention deficits (von Hippel et al., 2005). In addition, this task measures passive rather than active behavior, which arguably carries different moral and motivational force. A person who fails to seek the owner of a $100 bill perhaps differs from one who steals the $100 from its owner. More importantly, religiosity and prayer may have different effects on the two behaviors.

Another paradigm, developed by Mazur, Amir, and Ariely (2008), measures cheating using a challenging cognitive task, in which participants can falsely report better performance for financial gains. Cheating is commonly measured by comparing the mean number of problems solved between-groups (e.g., Mazur et al., 2008). However, this measurement of cheating could capture differences in the groups’ cognitive performance, as opposed to cheating, and does not allow for the identification of individual cheaters. Other researchers developed Mazur and colleagues’ (2008) cheating paradigm to measure cheating more precisely by comparing computer recorded performance with participants’ reported performance (e.g., Gino et al., 2011). It is unclear how convinced participants are of their anonymity in this paradigm, however, and differences in credulity could account for some of the results,
As noted in previous chapters, MTurk participants, despite being a highly valid and useful sample in many ways, are prone to cheat in social science experiments (Goodman et al., 2013), perhaps unsurprisingly given their poor remuneration. In Study 6, we used a novel paradigm that takes advantage of this natural pool of real cheaters. Specifically, non-Swahili speaking participants completed an “intuitive translation task” in which they were asked to intuit the English meaning of Swahili words (Owen, 2016), with the highest scorer winning a $100 prize. Because intuiting the answer was impossible (as validated in a pre-test), any correct answer was necessarily gotten by illegal means, thereby creating an easily quantified measure of cheating: the number of items participants get “correct.”

Method

Participants

A power analysis based on the effect sizes found in Experiment 2, on prayer’s effects on performance ($f^2 = .05$), was computed using GPower (Faul et al., 1992). GPower indicated that 214 participants were needed to achieve statistical power (1 - $\beta$) of 0.80 when $\alpha = 0.05$, two-tailed. Allowing for unusable participants, I recruited two hundred and fifty-four participants from Amazon’s Mechanical Turk (MTurk) for a study on “beliefs and intuition,” in exchange for a token payment of US $0.40. Of those, three reported using a phone or tablet and so did not meet the requirement of working from a desktop or laptop computer, leaving two hundred and fifty-one participants in the final sample.

One hundred and forty-two participants reported their gender as female, 107 participants reported their gender as male, and two reported their gender as “other.” Participants ages ranged from 19 to 75 ($M_{age}: 36$). One hundred and fifty-three participants (61%) reported their identity
as religious (76% of them Christian).

**Design and measures**

Participants were randomly assigned to one of two conditions: Prayer or Control.

Cheating was measured using a 17-item Swahili “intuitive translation” quiz (see Appendix I), developed by Owen and Halberstadt (Owen, 2016). Stimuli were validated in a pretest on 61 first and second year Otago University students, who guessed their meaning under supervision in a pen and paper questionnaire, so that cheating was impossible. Seventeen items, which could not be guessed by any of the participants, made up the final measure. Because this pretesting established that intuiting the meaning of these words was effectively impossible for a non-Swahili speaker, all correct translations were assumed to be ill-gotten, the result of cheating (e.g., by looking up the meanings online). Participants were incentivized to cheat with an offer of $100 reward for the highest score.

Because this paradigm provides objective evidence of cheating, I could also assess honesty in a second way, by asking participants whether they had cheated. Participants were asked to indicate any strategies they used to determine the meanings of the Swahili words (i.e., I used my intuition, I looked answers up, I received help from another person or entity, I know Swahili, I guessed, I used logic, and other).

Religiosity, views of God, locus of control, prayer behavior and experience, and perceptions of prayer’s effectiveness and ease were measured as described in Studies 1-5. Participants rated their perceptions of the intuitive translation task’s ease on a Likert scale, anchored at very difficult and very easy.

**Procedure**

Participants completed the study online, via a questionnaire written in Qualtrics (Qualtrics,
Participants provided informed consent and completed a demographic questionnaire. Embedded in the demographics questionnaire was a yes-or-no question regarding whether participants spoke any Bantu languages (e.g., Swahili). The procedure was the same as Studies 1-5 and the manipulation was identical to Studies 3 and 5.

Then, participants completed the Swahili translation test. All participants were told that they would be “completing an ‘intuitive translation’ task, in which you will try to guess the meanings of non-English words.” Half of the participants, randomly assigned, completed the prayer task beforehand, as in Study 5; control participant proceeded directly to the translation task. All participants were told:

Often we can intuit the meanings of words even if we are not familiar with a language. Below are the names for some common nouns in Swahili. Try to figure out what these words mean in English, using only your intuition. Write your guess in the blank space provided. The participant(s) with the highest score will win a bonus $100. Good luck!

Participants rated their perceptions of its ease, and reported their strategies for completing the task (i.e., the secondary honesty measure). In addition, participants who prayed rated how difficult they found writing a prayer, and the extent to which they thought praying would improve their performance on the intuitive translation task. Participants were debriefed and thanked for their time.

Results

Four participants were excluded from analyses because they failed the concentration check, eleven for not complying with instructions, and five for admitting to some Swahili language
proficiency, leaving a usable sample of 231.

**Cheating**

Because pretesting indicated that “intuitive translation” is impossible, all correct answers were considered ill-gained, the result of some form of cheating. The distribution of correct translations, which appears in Figure 6.1., showed that they were zero inflated (i.e., the modal response was no cheating), necessitating a zero-inflated count model of analysis. The observed variance to mean ratio of cheating counts was 5.24: 46.46 ($\bar{x} = 2.62; s^2 = 23.23$), suggesting overdispersion. A hurdle model was deemed appropriate because unlike other zero-inflated count models (negative binomial or Poisson), hurdle models interpret all zeroes as true zeroes, as well as meaningful and from one structural source (Hu, Pavlicova, Nunes, 2011; King, 1989; Mullahy, 1986; Rose, Martin, Wannemuehler, Plikaytis, 2006). In addition, in hurdle models, the two phases of analysis are not constrained to be identical (e.g., prayer may cause zero counts, but not affect degrees of cheating for those who cheated). Zero is interpreted as the hurdle or threshold for cheating, and any positive values (> 0) as evidence of cheating. The hurdle function estimates the probability that the hurdle is crossed (probability of participants cheating or not cheating; Hu et al., 2011; Rose et al., 2006).
The first phase of the model is truncated (i.e., analyzing only nonzero values) on a Poisson or negative binomial (NB) distribution.\textsuperscript{34} The second phase of the zero-inflated hurdle model is a binary logit analysis, which analyzes the extent to which prayer, religiosity, and views of God predict whether participants cheat or not. The first hurdle model was truncated with a Poisson distribution (model 1) and the second hurdle model was truncated with a NB distribution (model 2). The models were tested and compared in order to assess the effect of condition, moderated by

\textsuperscript{34} The Poisson distribution assumes an equal sample mean to sample variance. The negative binomial distribution appears similar to the Poisson distribution but with a longer tail. It is useful when the sample variance is greater than the sample mean and can account for over-dispersion.
religiosity, on cheating. Model comparisons can be viewed in Appendix J. The effect of an overall positive view of God (the inverse of Shariff et al., 2011) negative view of God score), was also included as a predictor in the model. Models were tested in R, using the user interface RStudio (R Team, 2017) and CRAN packages pscl (Jackman & Fearon, 2007), lmtest (Hothorn et al., 2015), aod (Lesnoff & Lancelot, 2012), MASS (Ripley et al., 2013), and countreg (Zeileis & Kleiber, 2016). The code can be found in Appendix K.

As seen in Appendix J, model two is the preferable model, despite its inability to account for over-dispersion at counts 16 and 17. Model 2, a hurdle model with a truncated negative binomial distribution with log link, showed that condition marginally, but not significantly, decreased cheating, \( b = -0.28, SE_b = 0.16, z (231) = -1.74, p = .08 \). Religiosity predicted an increase in positive cheating counts, \( b = 0.16, SE_b = 0.07, z (231) = 2.28, p = .02 \). Religiosity marginally moderated prayer’s effects on positive cheating counts, \( b = 0.12, SE_b = 0.07, z (231) = 1.74, p = .08 \). Positive views about God did not predict positive cheating counts, \( b = -0.08, SE_b = 0.06, z (231) = -1.28, p = .20 \).

Part 2 of model 2, a binomial with logit link, showed that condition did not predict whether participants cheated or not, \( b = 0.01, SE_b = 0.14, z (231) = 0.10, p = .92 \). Religiosity predicted whether participants cheated or not, \( b = 0.11, SE_b = 0.06, z (231) = 1.98, p = .05 \). Religiosity moderated prayer’s effect on cheating, \( b = -0.12, SE_b = 0.05, z (231) = -2.22, p = .03 \), with prayer decreasing the probability of participants cheating or not as religiosity increased. Positive views about God did not predict whether participants cheated or not, \( b = -0.09, SE_b = 0.06, z (231) = -1.5, p = .13 \).

For the significant findings found in model two (religiosity for positive counts; religiosity and religiosity by condition for zero counts hurdle), t-tests were examined and incidence rate ratios
(IRR) and odds ratios were computed. A partial Wald test of coefficients revealed that for positive counts, religiosity predicted an increase in positive cheating counts, $t(231) = 2.28$, $p = .02$. The IRR ($e^{0.164}$) was 1.18, suggesting that for every one-unit increase in religiosity the incidence of positive counts of cheating increased by 1.18, 95% CI [1.02, 1.36]. For zero counts, religiosity predicted an increased probability of participants crossing the hurdle to cheat, $t(231) = 1.98$, $p = .049$. The odds of crossing the hurdle to cheat increases by 1.117 ($e^{0.111}$) for every unit increase in religiosity, 95% CI [1.00, 1.25]. Praying did not significantly affect whether or not participants cheated, $t(231) = 0.10$, $p = .92$, $e^{-0.014} = 1.01$, 95% CI [0.10, 0.92]. However, as religiosity increased, praying, relative to the control, decreased the probability of participants cheating or not, $t(231) = -2.22$, $p = .03$, $e^{-0.115} = 0.89$, 95% CI [0.81, 0.10].

Figure 6.2. 95% Confidence intervals of incidence rate ratio (IRR) and odds ratios (OR).
Honesty

Due to the small number of cheating admissions (23 out of 100 cheaters), statistical analyses were very limited. Of the 23 participants, nine were in the prayer condition and 14 were in the control condition. Religiosity was not associated with whether participants admitted to their cheating.

Additional analyses

SBS comparisons

An independent-samples t-test was compared SBS scores between the MTurk samples (Studies 3, 4, & 5) and the NZ samples (Studies 1 & 2). MTurkers ($M = 0.92, SD = 2.66$) endorsed significantly more supernatural beliefs than New Zealand undergraduates ($M = -0.65, SD = 2.40$), $t(1413) = -7.92, p < .001$.

Correlations

Correlations between locus of control and praying behavior, religiosity, and views about God were examined as in Studies 1-5. Praying behavior, views about God, religiosity, and God locus of control predicted internal LOC.
Table 6.1.

*Pearson’s correlations between praying behavior, views about God, locus of control: God, and locus of control: Internal.*

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<td>1. Translation task: Ease</td>
<td>.01</td>
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<td>2. Prayer: Ease</td>
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<td>.40**</td>
<td>.38**</td>
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<td>.32*</td>
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<td>3. Prayer: Effectiveness</td>
<td>.25</td>
<td>.25</td>
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<td>4. Religiosity (SBS)</td>
<td>.70**</td>
<td>.77**</td>
<td>.36**</td>
<td>.71**</td>
<td>.74**</td>
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<td>5. Prayer experience</td>
<td>.69**</td>
<td>.20</td>
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<td>6. Prayer frequency</td>
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<td>7. Positive God views</td>
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<td>8. LOC: Internal</td>
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<td>.85**</td>
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<td>9. LOC: God</td>
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*p < .005*, *p < .001** [Bonferroni corrected]

**Discussion**

Study 6 primarily aimed to test an implication of prayer’s effects on self-control in an important domain associated with this ability: cheating. Results showed that for more religious participants, prayer decreased both the probability of cheating and the extent of cheating when it did occur. These results are consistent with the results from Studies 1-5, in which the effects of prayer were dependent on participants’ religious beliefs. Study 6 is particularly intriguing in light of Study 5, which showed differences in self-control in relation to monetary outcomes. Here, too, prayer may have increased self-control, and decreased cheating, through one of several mechanisms: Prayer may have primed the feeling of being watched, reminded participants of their standards and ideals, and increased their goal development and motivation.
Interestingly, religious belief itself predicted cheating, consistent with Guttman (1984) and Pruckner et al., (2008). These results do not support people’s intuitions that those who lack supernatural beliefs are untrustworthy (e.g., Edgell et al., 2016; Gervais et al., 2011). Furthermore, while prayer’s efficacy did decrease cheating by religious participants, it brought cheating down to a level achieved by nonreligious participants, rather than produce distinctively ethical behavior. Thus, a strong conclusion would be that among religious participants, prosocial self-controlled behavior may, in some circumstances, depend on religious priming. However, for people who do not hold supernatural beliefs, self-control may operate independently via other mechanisms.

Results from Study 6 also indicated that an overall positive view of God did not predict cheating. Although the result runs counter to the supernatural punishment hypothesis and Shariff et al.’s (2011) findings, prayer could have primed the feeling of being watched, consistent with the supernatural monitoring hypothesis, particularly among those who hold supernatural beliefs. This feeling may have been sufficient to increase self-control and inhibit cheating. Indeed, Piazza and colleagues’ “Princess Alice” (2011) and Bering and colleagues’ ghost (2005) manipulations were not designed to invoke a punishing supernatural agent, but rather to prime the feeling of being watched. However, the results of Study 5 suggested that prayer did not affect socially desirable responding, putting a supernatural monitoring hypothesis into question.

It is interesting to note that the majority of people who cheated did not admit to doing so. Indeed, the differences could not be fully analyzed due to the low number of participants who admitted to cheating, although the descriptive data suggest that participants were equally dishonest between conditions. If so, the results somewhat contradict the supernatural watcher hypothesis, since watched participants would presumably be motivated to admit to their cheating. However, this measure of honesty only captured cheating participants’ post hoc honesty. Participants who
felt like they were being watched likely cheated less at the outset. Therefore, the supernatural monitoring hypothesis cannot be ruled out.

Despite these provocative results, Study 6 has a number of limitations. Participants were asked if they spoke Swahili, rather than if they knew Swahili. Conceivably, participants could have known some words in Swahili but not enough to consider themselves a “speaker.” This ambiguity, however, can only account for the overall level of cheating, and cannot explain between group differences.

The paradigm used in this study represents only one domain of cheating. Thus, the results may not be generalizable to other types of cheating, much less other domains of moral or prosocial behavior. Theoretically, believers could be more moral in some domains, particularly areas in which there are clear guidelines, than in more ambiguous situations. Indeed, the instructions in the current task strongly implied but did not explicitly prohibit cheating, perhaps facilitating rationalization. However, if participants thought looking the answers up online was permissible, then one would expect them to admit to doing so.

Study 6 permitted yet another opportunity to explore the correlational relationship between praying behavior, views about God, and LOC. Inconsistent with Study 5, but consistent with the other MTurk samples (Studies 3 & 4), praying behavior, views about God, and God LOC predicted internal LOC. Thus, three of the four MTurk samples provided evidence supporting theories suggesting that prayer serves as a means to gain vicarious control through God, increasing one’s internal LOC, at least for Americans (Kay et al., 2010; Pyszczynski et al., 1999; Rothbaum et al., 1982; Spilka & Ladd, 2013). Studies 1 and 2 (the New Zealand samples) did not show these effects, suggesting that New Zealanders may not rely on God as a source of control. Together, these results provide some evidence for Kay and colleagues findings on the hydraulic relationship
between trust in God and trust in government. New Zealanders may not need God as a source of external control, because government and society sufficiently provide it.

In summary, the results of Study 6 suggested that while believers may be more honest or cheat less under some conditions, there are important qualifications: They have to be praying or otherwise primed to think about their religious beliefs, and the moral benefits of prayer may not occur for the reasons people intuitively assume (i.e., accountability to supernatural; Gervais et al., 2011; Edgell et al., 2016). Prayer, like other religious primes, may increase accountability, by priming believers’ standards or ideals and accountability to a supernatural watcher, but the proximate cause may be increased self-control.
Chapter 7

General Discussion

Review: Prayer’s divergent effects on cognitive performance

Prayer is historically and culturally indelible (Heiler, 1932; Pew Research Center, 2014; Pratt, 1920). Even non-believers pray (Pew Research Center, 2014), presumably because they believe it will help them achieve a desired goal (e.g., Zaleski & Zaleski, 2005). But despite many claims about prayer’s efficacy, scientists don’t know if, how, or why prayer works. The evidence on prayer’s efficacy is inconsistent and insubstantial. What rigorous research exists focusses on the subjective correlates and effects of prayer, particularly in relation to well-being and coping, rather than on the objective benefits that are often the subject of the prayers (e.g. sports outcomes; Jones, Cox, & Navarro-Rivera, 2014). Yet there is reason to think that these subjective mechanisms could link prayer, particularly petitionary prayer, to executive functioning and cognitive performance. These links make it plausible that praying, say, for a good outcome on an exam could in fact bring that outcome about (without divine intervention). The goal of this thesis was thus to investigate prayer’s effects on performance and the potential mediating mechanisms that could account for its effects.

Specifically, this project aimed to examine the effects of prayer on solving anagrams, a particular but common measure of problem-solving ability, divergent thinking, focused attention, and effort (e.g. Alexander et al., 2007; Baumeister et al., 1998; Elliot et al., 2007; Gavurin, 1967, 1975; Sarason, 1984). In two studies, one in which prayer content was held constant and one in which participants were free to generate their own prayers, praying produced different effects depending on participants’ religious beliefs. Believers solved more anagrams when praying than
when planning their day (or reciting words that they believed were a meditation or neutral statement); nonbelievers solved fewer.

A number of mechanisms were considered as possible explanations of these effects (see Chapter 1), which received varying support across the six studies. In Study 1, prayer increased positive affect for religious believers, but decreased positive affect for nonbelievers, mirroring the performance data and perhaps reflecting perceived social support, but positive affect did not mediate prayer’s effects. Furthermore, the effects on positive affect were not replicated in Study 2, and content analyses in that study failed to uncover any differences in the use of positive emotion words (indeed, there were, interestingly, no detectable differences at all in prayer contents as a function of religious belief). Taken together, the results offer little support for the hypothesis that prayer affected anagram performance via its emotional consequences, suggesting that prayer did not influence performance for the religious, by virtue of being an imagined social support interaction.

Studies 1 and 2 also investigated the potential for prayer to work via arousal. Again, though, the results in the two studies were inconsistent. In Study 1, religious believers reported greater arousal after praying, and arousal did indeed mediate prayer’s effects on performance. However, the reverse mediational path was also significant, raising the possibility that arousal followed from rather than caused good performance. In any case, the results were not replicated in Study 2.

Study 2 also permitted a test of the attributional account of prayer, with initially promising results. Prayer increased religious participants’ state attributions of internal control over anagram performance, and these attributions mediated prayer’s effects on performance. However, the opposite was also true, with performance mediating the effects of prayer on internal attributions.
of control. Thus, it is unclear in this study whether believers felt more in control of their fate after praying, with downstream effects on their performance, or whether prayer improved their performance via some other means, which they then attributed internally retroactively. To resolve the ambiguity, Study 3 measured attributions of control without the anagram task (thereby preventing the possibility of retroactive attributions); participants in that study failed to make enhanced internal attributions following prayer, calling the attributional account into question. There was also no evidence for an increase in implicit associations of control with the self, in Study 4.

One unexpected finding, perhaps unsurprising in retrospect, was that religious participants in Study 3 differed in their estimates of prayer’s effectiveness, compared to nonreligious participants. (Participants gave equivalent estimates of the effectiveness of the control (planning) task, regardless of religiosity.) However, perceptions of prayer’s effectiveness did not translate into different predictions about anagram performance; despite claiming to find prayer more effective in improving anagram performance, religious participants did not predict that they would solve more anagrams, casting doubt on an expectation account of prayer’s effects on performance.

Study 5 examined a different possible mechanism of prayer – self-control – measured on an established measure of delayed gratification. Results showed that as religiosity increased, prayer was increasingly beneficial to the ability and/or willingness to forego immediate rewards. The effect is particularly relevant for interpreting the anagram data, as success in this task is largely a function of perseverance, with high correlations (−.82 and −.79 in Studies 1 and 2 respectively) between giving up (pressing the pass button) and the number correctly answered.

One implication of the self-control account was examined in the final study, which leveraged online participants’ temptation to cheat. Just as religious petitioners may have gained
the self-control to persist at the anagrams, they may have gained the self-control to resist breaking the rules in Study 6. In fact, religious participants, but not non-religious participants, benefitted from prayer, and were less likely to cheat on the Swahili translation test compared to control participants. Interestingly, although nonreligious participants were not influenced by prayer, neither were they particularly prone to cheat. Prayer, that is, brought the otherwise relatively deceptive religious participants back to the level of nonreligious participants.

Additional analyses explored the correlational relationship between praying behavior, God LOC, and internal LOC. In all studies, Pearson’s correlations revealed positive strong correlations between praying behavior and God LOC. However, the correlational data on prayer’s relation to an internal LOC was mixed; In Studies 1, 2, and 5, internal LOC did not correlate with praying behavior or God LOC, inconsistent with the literature suggesting that a high God LOC is equivalent to a high internal LOC and that prayer may serve as a means to gain vicarious control (e.g., Gloss, 2009 cite in Spilka et al., 2013; Kay et al., 2009; Kay et al., 2010; Welton et al., 1996). In Studies 3, 4, and 6, Pearson’s correlations revealed robust positive correlations between high internal LOC, more positive views about God, praying behavior, and a God LOC.

In Chapter 4, I speculated that the inconsistent findings could be partially explained by the change in samples (NZ to USA) and Kay and colleagues’ (2010) findings on the hydraulic relationship between trust in God and trust in government. When Kay et al., (2010) experimentally lowered faith in government, they found increased faith in God. They concluded that peoples’ reliance on external sources of control was flexible and trust-dependent. New Zealand ties with Denmark as the least corrupt country in the world, while the U.S.A. ranks at 18th (Transparency International, 2016). New Zealanders may not rely on God as a source of vicarious control in the same way as Americans because they trust the government to provide the control they need.
However, the speculated cultural differences did not replicate in Study 5 (U.S. sample); Internal LOC did not correlate with God LOC or praying behavior. Nonetheless, in three out of the four U.S. samples, internal LOC correlated strongly and positively with God LOC and praying behavior. Future studies could explore these cultural differences experimentally, along with the moderating effects of trust in government versus trust in God.

Exploratory correlational analyses also examined how views about God predicted various indices of self-perception and well-being. As discussed in Chapter 1, some previous research has found that positive views about God correlate positively with self-esteem (Benson & Spilka, 1973; Spilka et al., 1975) and negatively with psychopathologies (Bradshaw et al., 2008), but the data are inconsistent. In one study, positive views about God predicted a higher internal LOC (Wong-McDonald & Gorsuch, 2004). However, in another study, positive views about God did not correlate with internal LOC (Benson & Spilka, 1975).

In Study 2, positive views about God correlated positively with praying behavior and God LOC, but not internal LOC, consistent with the Benson and Spilka’s (1975) results. In Studies 3-6, positive views about God predicted a higher internal LOC, consistent with Wong-McDonald and Gorsuch (2014), suggesting that views about God could play a moderating role in prayer’s effects. However, positive views about God did not moderate prayer’s effects on cognitive performance or internal attributions of control (Study 2), nor did it moderate prayer’s effects on cheating rates (Study 6).

In sum, the research in this project shows that petitionary prayer interacts with religiosity to influence performance on an anagram task. Of the mechanisms examined, self-control is arguably the most plausible, not only because it was reliably influenced by prayer, but also because it is strongly linked to cognitive performance. Anagram performance in particular is strongly
predicted by effort and persistence, both factors requiring self-control, and anagram tasks have
indeed been used directly as a measure of self-control (e.g., Baumeister et al., 1998). Unfortunately, I was not able to test a full mediational model, in which both anagram performance
and self-control were measured in the same paradigm, but that is an obvious next step for future
research. In addition, future research could manipulate all constructs – prayer, self-control, and
even religiosity – to gain more clarification about the causal direction of the effects.

Limitations

The studies in this thesis have attempted to rigorously examine the interaction of prayer
and religiosity on cognitive performance, with each construct operationalized in a relatively
specific way – as petitionary prayer, supernatural belief, and anagram performance, respectively.
But in fact all three components are broad, multifaceted, and poorly defined, which may account
for the lack of any significant literature on the prayer-performance relationship. Thus, I have
intentionally sacrificed generalizability for the sake of scientific progress, but it is useful to
consider how other facets of prayer, religiosity, and performance, might produce different effects.

Prayer

The focus of this thesis was limited to a petitionary prayer manipulation, practiced in a
psychology experiment, either in the lab or from participants’ home computer. Ladd and
colleagues (2015) suggested that lab experiments that manipulate prayer via “prayer-on-demand”
experimental designs may lack validity. Prayer in the lab may not represent prayer as naturally
practiced by petitioners. In Studies 3, 4, and 5, the validity of prayers and their correlates with
religiosity and frequency of prayer were investigated. Participants rated their perceptions of their
prayer’s typicality from very atypical to very typical. Results suggested that 50 – 60% of
participants considered their prayers to reflect typical to very typical prayers, regardless of religiosity.

The results from Studies 3, 4, and 5 thus suggest, somewhat surprisingly, that the majority of practiced petitioners view the prayers they offered in the current studies as similar to their typical prayers. Nonetheless, the experiments were artificial situations, as people probably do not normally pray in psychology experiments. Typically, personally salient needs motivate petitionary prayers (e.g., Janssen et al., 2000), rather than experiment instructions or an anagram task. These motivations could affect the content and expression of prayer, which likely have implications for the effects of prayer on cognitive performance and self-control. Furthermore, the fact that participants knew they were participating in a psychology experiment, and perhaps assumed that their prayers would be read by the experimenters (though this was not stated explicitly), may have influenced prayer content or participant motivations. Religious participants, for example, may have been more motivated to prove prayer “works” and tried harder on the anagram task as a result. However, if prayer primed demand characteristics for believers, I would expect to find increased socially desirable responding (Brewer & Crano, 2000), as a function of religiosity, a prediction not born out in Study 5. Still, it goes without saying that the prayer manipulations in the current studies should be replicated in more naturalistic environments. Future research should further examine the ecological validity of the self-control measure, which, while used extensively in the literature, may not reflect participants’ choices when real resources are at stake.

Furthermore, petitionary prayer is itself only one type (albeit the most common and easily conceptualized and operationalized type) of prayer (e.g., Heiler, 1932; Poloma & Pendleton, 1991). For instance, prayer can be spoken or silent, spontaneous or planned, and institutionalized or individualized. Different variables could interact to inspire different types of praying, which
appear to have different functions and effects that could extend to cognitive performance. For instance, meditative prayer may cause effects via relaxation (e.g., Benson et al., 1975), decreasing an individual’s state of arousal, thereby increasing or decreasing cognitive performance (e.g., depending on the complexity of the task, among other factors; Zajonc, 1965). Future research should examine how varying types of prayer could influence cognitive performance and the varying mechanisms involved.

Religiosity

Religiosity was operationalized in this project as supernatural beliefs. However, religiosity, like prayer, is a vague and multifaceted construct (Oman, 2013). Researchers conceptualize religiosity in a variety of ways, such as private religious behavior (e.g., frequency of prayer), public religious behavior (e.g., religious service attendance), orientation (i.e., extrinsic vs intrinsic), and identity (e.g., self-identification) (Oman, 2013). These different definitions of religiosity could interact differently with petitionary (or other types of) prayer to affect cognitive performance. For instance, petitionary prayer could impair cognitive performance for individuals with extrinsic religious orientations (i.e., using religion for utilitarian purposes, such as social advancement; Allport & Ross, 1967), as they may not hold supernatural beliefs despite attending religious services. Future research should explore how different facets of religiosity interact with petitionary prayer, and other types of prayer, to influence cognitive performance. It should be noted, though, supernatural beliefs are a fundamental aspect of religiosity (Jong & Halberstadt 2016), and have the advantage of being measurable even among people who don’t identify as “religious”. Given the frequency of secular prayer cited in Chapter 1, it is particularly important to operationalize religiosity in a way that accounts for participants who are effectively or implicitly religious, but do not identify as such.
Any conclusions about the interaction between prayer and religiosity – however it is defined – will always be somewhat limited as long as religiosity is treated as an individual difference. Ultimately, researchers will want to manipulate religiosity in the laboratory to make confident inferences about its causal effects on performance. Although fraught with practical (and ethical) complications, religiosity can be experimentally manipulated, at least when operationalized as religious belief (e.g., Jong, Halberstadt, & Bluemke, 2012; Gervais & Norenzayan, 2012). Furthermore, different beliefs (e.g., belief in a God who interferes in daily life versus in a spiritual force that takes no interest in the affairs of humans) may interact uniquely with prayer to influence cognitive performance and self-control. Further research should examine how manipulated religious belief (and disbelief) interacts with petitionary prayer and other types of prayer to affect cognitive performance, in order to identify the beliefs that interact with petitionary prayer to improve or, alternatively, impair cognitive performance and self-control.

**Anagrams and cognitive performance**

Anagram tasks reflect problem-solving abilities, divergent-thinking, focused and sustained attention, and also effort (Alexander et al., 2007; Baumeister et al., 1998; Elliot et al., 2007; Gavurin, 1967, 1975; Sarason, 1984). These skills are important in many cognitive domains and contribute substantially to achievement (Heckman, 2006) and earnings (Burks, Carpenter, Goette, & Rustichini, 2009; Heckman, 2006). Nevertheless, they are obviously not the only or even most significant cognitive skill, and future studies should replicate the current work other measures of cognitive performance. Moreover, any study on cognitive performance should be accompanied by more direct measures of mechanism (e.g., working memory capacity or attention) to better understand what cognitive skills are being impaired or facilitated in a given performance domain.
Executive function, self-regulation, and attention

This research examined petitionary prayer’s effects in two domains of self-control: delayed gratification (i.e., temporal discounting) and temptation resistance (i.e., cheating). However, there are many other domains of self-control that prayer might interact with religiosity in a different way. As discussed in Chapter 1, Friese and colleagues (2014a, 2014b) found that a brief period of personal, undirected prayer buffered the effect of self-control depletion on a Stroop task. While Friese and colleagues did not find evidence of religiosity as a moderator, they did find that the extent to which participants felt their prayer mirrored a social interaction mediated prayer’s effects on self-control. Future research should further investigate how social facilitation and perceived social buffering might mediate prayer’s effects on self-control.

Adams and colleagues (2016) reported somewhat similar effects to Friese et al., (2014a, 2014b) and to the results from this project. Adams et al. found that prayer increased performance on the Stroop task for the highly religious and word response times for all participants, but considerably more for highly religious participants. Friese et al., (2014a, 2014b) attributed prayer’s effects to self-control while Adams and colleagues (2016) interpreted them in terms of Kahneman’s attention model (1973). Attention and self-control are conceptually and empirically entangled, however (Englert & Bertrams, 2015). Both reflect cognitive effort (Inzlicht & Schmeichel, 2012; Kahneman, 1973). Self-control appears to be attention-driven (Inzlicht & Schmeichel, 2012) and attentional regulation requires self-control (Englert & Bertrams, 2015). Future research should further examine how prayer affects motivation and attention to differentially predict changes in self-control.

N.Z. to U.S.A. Sample

Prayers effects on performance were demonstrated in New Zealand on an undergraduate
student sample in a laboratory setting, but studies examining the mechanisms of this phenomenon were examined on American MTurkers in their homes. Both the United States and New Zealand are western, English speaking, and largely Christian countries (Pew Research Center, 2014; Statistics New Zealand, 2013). Nevertheless, it is conceivable that these samples could differ in some relevant ways. For instance, Americans are more religious and less secular than New Zealanders. Only 20-23% of Americans identify as atheist, agnostic, or not religious (Hout, Fischer, & Chaves, 2012; Pew, 2014). According to the Statistics New Zealand (2013), nearly half of New Zealanders (42%) report having no religious identity, almost double that of the United States. MTurk workers’ unbelief rates (as measured by religious identification) are reportedly double that of the general U.S. population, with approximately 40% identifying as secular (Lewis et al., 2015). Nevertheless, my data revealed that American MTurkers endorsed significantly more supernatural beliefs than New Zealand undergraduates. Although it is not clear why the proportion of religious participants in the sample, per se, could explain the results on performance in Studies 1 and 2 of the current thesis, it will be important to replicate those studies in the American populations and in other cultural contexts.

Similarly, the experimental conditions across studies, while not obviously able to account for the results, should be better controlled in future work. The laboratory is a controlled environment with minimal distractions, whereas online participants’ environments are more variable and presumably more prone to random error. Research on MTurk sampling shows that online studies using the service generally show high internal and external validity (Berinsky, Huber, and Lenz 2012; Buhrmester, Kwang, and Gosling 2011; Horton, Rand, and Zeckhauser 2011), suggesting that difference in experimental locations may not be a fatal confound.
Exclusively western Christian demographic

This project largely sampled a western Christian population and the effects of prayer found may not extend to other populations. The Christian God is an anthropomorphized, male, omnipotent, and omnipresent deity and communication with the Christian God (i.e., prayer) may look different and have distinctive effects compared to communication with other Gods and in other religious traditions. For instance, in Hinduism, some supernatural deities are female (e.g., Lakshmi), with respective mantras or prayers particular to them. If perceptions of the supernatural deities matter, as they do in some studies (e.g., Shariff & Norenzayan, 2011; Laurin et al., 2012), then these perceptions could differentially affect performance. Even though views about God did not moderate prayer’s effects in the current studies, other cultural models of human-god interaction might reveal very different interactive effects. Christianity offers particular standards of behavior and motivation to comply via specific supernatural rewards and punishments (e.g., heaven versus hell). If the mechanism(s) mediating prayer’s effects on performance depend on prescribed standards and ideals, then these standards may differentially affect self-monitoring, motivation, and goal development and, thus, task performance and self-control. Further research is needed to examine whether the effects found in this project replicate on more diverse samples and how these variables interact, cross culturally, to affect cognitive performance.

Applications and implications

People typically assume that petitionary prayer has positive effects, and researchers typically investigate the effects of prayer on believers or practiced petitioners, perhaps because they assume only religious people pray. However, research indicates that nonbelievers pray and the studies in this project show that prayer’s effects on the non-religious are not just neutral, but are sometimes detrimental. Specifically, results from this project suggest that private petitionary
prayer, in certain circumstances, can have deleterious consequences on cognitive performance and self-control, particularly for nonreligious individuals. One could argue that nonbelievers are vulnerable to the negative effects of prayer, or at least have less to gain from prayer. Private petitionary prayer appears to increase cognitive performance and self-control for the religious, partially supporting people’s intuitions that prayer has positive outcomes. Religious people may benefit from praying in regard to cognitively demanding tasks and in situations requiring self-control.

Prayer’s effects on self-control for believers could be extended to other domains associated with self-control. For instance, prayer has already been associated with other domains requiring self-control, such as alcohol cravings and alcohol consumption (Galanter et al., 2016; Lambert et al., 2010), aggression (Bremner et al., 2011), and infidelity (Fincham et al., 2010). Prayer’s effects on self-control might also extend to other socially important issues, such as smoking cessation, obesity, and academic achievement.

Though these implications of prayer driven effects on self-control and performance, whether positive or negative, are intriguing and important, I reiterate that they must be viewed with caution due to the narrow scope of this research and the associated limitations regarding generalizability. Further research should examine how these results can be replicated, ideally with the concepts and constructs being experimentally manipulated. In addition, further research should examine the generalizability of these results not only in field experiments but also cross-culturally. Nevertheless, this research indicates that the subjective effects of prayer could translate to objective performance.
References


Cleveland, C., Finez, L., Blascovich, J., & Ginther, N. (2012). For better or for worse: The effect of superior and inferior teammate performance on changes in challenge/threat


of Chicago.


Appendix A

Anagram list, ranging from easy - hard (Sherman, as cited in Anderson, 2010).

1. OPEEL (elope)
2. HOCIR (choir)
3. VARBE (brave)
4. BIASS (abiss; absis; basis)
5. ONERSP (person)
6. TOTID (dotti; ditto)
7. ATHEW (wheat)
8. VAHEY (heavy)
9. NISVIO (vision)
10. PLITO (pilot)
11. CINIG (icing)
12. CENRET (centre, center, necter; recent)
13. PPOCRE (copper)
14. URPLEP (pulper, purple)
15. LEVERC (clever)
16. SEMYS (messy)
17. CEENI (niece)
18. FERIG (grief)
19. TMOMNE (moment)
20. RAGUE (argue)
Appendix B

Prayer Experience Subscale (Paloma & Pendleton, 1991)

Please answer the following questions about some of the experiences you might have had during prayer. How often have you experienced the following?

<table>
<thead>
<tr>
<th>Experience</th>
<th>Never</th>
<th>Once or twice</th>
<th>Occasionally</th>
<th>Regularly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experienced a deep sense of peace and well-being.</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Felt the strong presence of God.</td>
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<td>○</td>
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<tr>
<td>Received what you regarded as a definite answer to a specific prayer request.</td>
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<tr>
<td>Felt divinely inspired or “led by God” to perform some specific action.</td>
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</table>
Adapted Prayer Experience Questionnaire (Dein & Littlewood, 2008)

Please answer the following questions as fully as possible. For most of the questions, you may choose as many answers as you wish.

Choose as many options as you want. Do you:

☐ Repeat a formal or written prayer?
☐ Make up your own prayer?

Choose only one. When you pray, how often do you pray for anything specific?

☐ Never
☐ Seldom
☐ Sometimes
☐ Often
☐ Always

Choose as many options as you want. Do you pray for anything specific? If so, which of these have you prayed about:

☐ Healing for yourself
☐ Healing for people you know or do not know
☐ Personal and economic difficulties
☐ Better relations with people close to you, including children
☐ For other people’s difficulties
☐ Global issues, e.g., world peace
☐ Personal salvation or spiritual development
☐ Community salvation
☐ A revelation
☐ A miracle
☐ Personal strength
☐ Moral strength
☐ Forgiveness
☐ Inner peace
☐ Power
☐ Material or physical things
☐ Thanksgiving or praise

What have you prayed for in the last year? Please give some actual examples.
Appendix C

Adapted Causal Dimension Scale II (McAuley et al., 1992).

Study 2 instructions: Now think about why you performed the way you did on the anagram task. Rate the cause or causes of your performance on the scales below.

Study 3 instructions: People’s thoughts differ from moment to moment. Think about how you will perform on the anagram task. Rate the cause or causes of your performance on the scales below.

<table>
<thead>
<tr>
<th>Factor</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tr>
<td>That reflect an aspect of the situation.</td>
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<td>Not manageable by you.</td>
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<td>That are temporary.</td>
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<td>You cannot regulate.</td>
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<td>Over which others have no control</td>
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<td>Outside of you.</td>
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<td>Variable over time.</td>
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<td>Not under the power of other people.</td>
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<td>About others.</td>
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<td>Over which you have no power.</td>
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<td>That reflect an aspect of yourself.</td>
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<td>Manageable by you.</td>
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<td>That are permanent.</td>
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<td>You can regulate.</td>
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<td>Over which others have control.</td>
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<td>Inside of you.</td>
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<td>Stable over time.</td>
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<tr>
<td>Under the power of other people.</td>
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<td>About you.</td>
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<tr>
<td>Over which you have power.</td>
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</table>

180
<table>
<thead>
<tr>
<th>That are changeable.</th>
<th>That are unchangeable.</th>
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<tbody>
<tr>
<td>Other people cannot regulate.</td>
<td>Other people can regulate.</td>
</tr>
</tbody>
</table>
Appendix D

Perceptions of anagram difficulty and performance.

[How would you rate your performance on the anagram task in relation to your peers?] [How do you think you will perform on the anagram task?] Please use percentiles (e.g., 75th percentile means a score greater than that achieved by 75% of your peers).

How many of the 5 anagrams do you think you will get correct?

Using the scale below, please rate how difficult you [found] [predict] the ANAGRAM TASK?

<table>
<thead>
<tr>
<th>Very difficult</th>
<th>Difficult</th>
<th>Somewhat difficult</th>
<th>Neither difficult nor easy</th>
<th>Somewhat easy</th>
<th>Easy</th>
<th>Very easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
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</table>
Appendix E

Perceptions of writing task (prayer or plan)

Using the scale below, please rate how difficult you found the WRITING TASK?

<table>
<thead>
<tr>
<th>Very difficult</th>
<th>Difficult</th>
<th>Somewhat difficult</th>
<th>Neither difficult nor easy</th>
<th>Somewhat easy</th>
<th>Easy</th>
<th>Very easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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<td>O</td>
</tr>
</tbody>
</table>

To what extent do you think your prayer reflects a typical prayer?

<table>
<thead>
<tr>
<th>Very atypical</th>
<th>Atypical</th>
<th>Somewhat atypical</th>
<th>Neither typical nor atypical</th>
<th>Somewhat typical</th>
<th>Typical</th>
<th>Very typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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</tbody>
</table>

Do you think writing [a prayer] [your plans] will improve your performance on the anagram task?

<table>
<thead>
<tr>
<th>Definitely not</th>
<th>Probably not</th>
<th>Might or might not</th>
<th>Probably yes</th>
<th>Definitely yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
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</table>
Appendix F

Concentration Check

Recent research on decision making shows that choices are affected by context. Differences in how people feel, their previous knowledge and experience, and their environment can affect choices. To help us understand how people make decisions, we are interested in information about you. Specifically, we are interested in whether you actually take the time to read the directions; if not, some results may not tell us very much about decision making in the real world. To show that you have read the instructions, please ignore the question below about you are feeling and instead check only the “none of the above” option as your answer. Thank you very much.

☐ interested
☐ distressed
☐ excited
☐ upset
☐ strong
☐ guilty
☐ scared

☐ hostile
☐ enthusiastic
☐ proud
☐ irritable
☐ alert
☐ ashamed
☐ inspired

☐ nervous
☐ determined
☐ attentive
☐ jittery
☐ active
☐ afraid
☐ none of the above
Appendix G

Latent growth curve analysis R code.

# differences in k by condition and sbs
# load packages
library(lavaan)

# make data matrix of dependent measures
# name it discount
discount <- c("LOGsmk", "LOGmdmk", "LOGlrgk")
# make covariance matrices for dependent measures
x.cov <- cov(k[,discount])
# establish means for dependent measures
x.mean <- colMeans(k[,discount])
# name dependent measures
names(x.mean) <- colnames(x.cov) <- row.names(x.cov) <- c("LOGsmk", "LOGmdmk", "LOGlrgk")

# combine all measures in data matrix
x.vars <- c("LOGsmk", "LOGmdmk", "LOGlrgk", "dummycond1", "dummycond2", "sbs_c", "SES")
# make covariance table of all measures
x2.cov <- cov(k[,x.vars])
# establish means for all variables
x2.mean <- colMeans(k[,x.vars])
# name measures
names(x2.mean) <- colnames(x2.cov) <- rownames(x2.cov) <- c("LOGsmk", "LOGmdmk", "LOGlrgk", "Cond", "sbs_c", "SES")

# Model 1: Intercept only model. Intercept not permitted to vary.
mod1l <- 'i =~ 1*LOGsmk + 1*LOGmdmk + 1*LOGlrgk
#and the variance of the mean latent intercept is constrained at 0 for each level
i~~0*i

LOGsmk~~r*LOGsmk
LOGmdmk~~r*LOGmdmk
LOGlrgk ~~ r*LOGlrgk
'

#instructions for presenting results
order = c ("df", "chisq", "rmsea", "srmr", "cfi")

#provide (1) covariance matrix (2) time period means
(3) # of obs
fit1 <- growth(model1, sample.cov = x.cov, sample.mean= x.mean, sample.nobs= 295)

fitmeasures(fit1, fit.measures = order)

#Model 2: Intercept allowed to vary but still intercept only model

model2 <- '
i =~ 1*LOGsmk + 1*LOGmdmk + 1*LOGlrgk
LOGsmk~~r*LOGsmk
LOGmdmk~~r*LOGmdmk
LOGlrgk ~~ r*LOGlrgk
'

#instructions for presenting results
order = c ("df", "chisq", "rmsea", "srmr", "cfi")

#provide (1) covariance matrix (2) time period means
(3) # of obs
fit2 <- growth(model2, sample.cov = x.cov, sample.mean= x.mean, sample.nobs= 295)

fitmeasures(fit2, fit.measures = order)

#Model 3: Extension of linear growth model adding slope
#constrained slope variance
model3 <-'
i =~ 1*LOGsmk + 1*LOGmdmk + 1*LOGlrgk
s =~ 0*LOGsmk + 0*LOGmdmk + 0*LOGlrgk
s~0*1
s~0*i
#residual variance
LOGsmk~~r*LOGsmk
LOGmdmk~~r*LOGmdmk
LOGlrgk ~ r*LOGlrgk
'

#instructions for presenting results
order = c ("df", "chisq", "rmsea", "srmr", "cfi")

#provide (1) covariance matrix (2) time period means (3) # of obs
fit3 <- growth(model3, sample.cov = x.cov, sample.mean = x.mean, sample.nobs = 295)
fitmeasures(fit3, fit.measures = order)

#Model 4: Unconstrained model
model4 <- 'i =~ 1*LOGsmk + 1*LOGmdmk + 1*LOGlrgk
s =~ 0*LOGsmk + 1*LOGmdmk + 2*LOGlrgk
#residual variance
LOGsmk~~r*LOGsmk
LOGmdmk~~r*LOGmdmk
LOGlrgk ~ r*LOGlrgk
'

#instructions for presenting results
order = c ("df", "chisq", "rmsea", "srmr", "cfi")

#provide (1) covariance matrix (2) time period means (3) # of obs
fit4 <- growth(model4, sample.cov = x.cov, sample.mean = x.mean, sample.nobs = 295)
fitmeasures(fit4, fit.measures = order)
# Model 5: including regressions

```r
model5 <- '  # intercept
  i =~ 1*LOGsmk + 1*LOGmdmk + 1*LOG1rgk
  # slope
  s =~ 0*LOGsmk + 1*LOGmdmk + 2*LOG1rgk
  # regression
  s + i ~ Cond*sbs_c
',

fit5 <- growth(model5, sample.cov = x2.cov, sample.mean = x2.mean, sample.nobs = 295)
```
Appendix H

Latent growth curve analysis model comparisons and results.

Five competing models were tested for each hypothesis, starting with a highly constrained model and successively removing the constraints with each subsequent model. The first two models were intercept-only models, for which the slope (i.e., rate of change) was constrained to zero. In the first model, the intercept was defined as equally influencing temporal discounting across each of the three levels (small, medium, and large); the variance of the mean latent intercept was constrained at zero for each level and the residual variances were forced to be equivalent across each level. In the second intercept-only model, the intercept variance was allowed to be greater than zero but the residual variances were constrained to be the same across each level of temporal discounting. In the third model, a random slope was added but the slope parameter was configured to zero, and the slope was forced to be uncorrelated with the intercept. The intercept and its variance were left in the model, however, the residuals were still constrained to be equal. In the fourth model, the slope and intercept were allowed to vary, but the residual variances were still constrained. The predictors (condition and religiosity) and control (socioeconomic status) were added to the model. In the fifth model, all constraints on the residual variances were removed.

Hyperbolic \( k \).

Hyperbolic \( k \) values were calculated in SPSS using the syntax provided by Gray and colleagues (2016). As is typical with this measure, small, medium, and large hyperbolic \( k \) distributions were positively skewed (skewness = 1.678, 2.454, 2.645; kurtosis = 2.212, 5.46, 6.585), and the data were log transformed to better approximate a normal distribution. The dataset was imported into RStudio (Team R, 2017) as a data frame. Then, the five models described above were tested. As constraints were removed, the models got successively better (see. Table AH.1.).
Chi-square statistics showed a significant decrease from model one, $\chi^2 (7) = 974.591$ to model five $\chi^2 (3) = 0.192, p = .979$, suggesting model five was both the best fit and a good fit. The root mean square error of approximation (RMSEA) decreased from 0.685 to < 0.001, suggesting that model five was the best fit, and an excellent fit (MacCallum, Browne, & Sugawara, 1996), and the SRMR decreased from 0.525 to 0.007, indicating that model five was an excellent fit. The comparative fit index (CFI) increased from 0.00 to 1, suggesting model 5 was a good fit (> 0.95) (Hu & Bentler, 1999). Across models the residuals decreased, as the error variance moved into the intercept and variance and slope means.
Table AH.1.
Comparison of model fits for hyperbolic $k$.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>974.59</td>
<td>306.26</td>
<td>306.26</td>
<td>14.03</td>
<td>0.19</td>
</tr>
<tr>
<td>RMSEA</td>
<td>.69</td>
<td>.41</td>
<td>.45</td>
<td>.11</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>SRMR</td>
<td>.52</td>
<td>.15</td>
<td>.15</td>
<td>.04</td>
<td>.01</td>
</tr>
<tr>
<td>CFI</td>
<td>&lt; 0.001</td>
<td>0.68</td>
<td>0.67</td>
<td>0.99</td>
<td>1</td>
</tr>
<tr>
<td>Residuals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.65</td>
<td>.13</td>
<td>.13</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>Small $k$:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium $k$:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large $k$:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept mean</td>
<td>-1.97</td>
<td>-1.97</td>
<td>-1.97</td>
<td>-1.75</td>
<td>-1.60</td>
</tr>
<tr>
<td>Intercept variance</td>
<td>n/a</td>
<td>.52</td>
<td>.52</td>
<td>.517</td>
<td>.56</td>
</tr>
<tr>
<td>Slope mean</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td>-.22</td>
<td>-.18</td>
</tr>
<tr>
<td>Slope variance</td>
<td>n/a</td>
<td>n/a</td>
<td>.05</td>
<td>.02</td>
<td>.05</td>
</tr>
<tr>
<td>Covariance</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>.003</td>
<td>-.04</td>
</tr>
</tbody>
</table>

Condition did not affect the mean value of linear slopes (i.e., rate of change between levels), $b = 0.01$, $SE_b = 0.01$, $z (295) = 0.91$, $p = .36$, 95% CI [-0.01, 0.04]. Religiosity did not predict the mean value of linear slopes, $b = -0.01$, $SE_b = 0.01$, $z (295) = -1.10$, $p = .27$, 95% CI [-0.015, 0.004]. The mean value of linear slopes confirmed the expected moderation of religiosity of condition’s effects, controlling for socioeconomic status, $b = -0.01$, $SE_b = 0.01$, $z (295) = -2.05$, $p = 0.041$, 95% CI [-0.02, 0.0001], showing that as religiosity increased, prayer decreased.
Figure A.H.1. Latent growth model showing religiosity’s moderation of prayer’s effect on changes in hyperbolic k between small, medium, and large rewards, controlling for socioeconomic status.  

35 In Figures AH.1., and AH.2., condition was dummy coded. The centered supernatural belief scores were multiplied by the dummy condition to create an interaction terms.
Immediate choice ratios

To test the hypothesis that religiosity would moderate rates of temporal discounting across levels of small, medium, and large rewards, five models ranging from most constrained to least constrained were compared in the same way as for hyperbolic k. There was a significant decrease in $\chi^2$ using chi-square statistics from model one, $\chi^2 (7) = 996.706, p < .001$ to model five $\chi^2 (3) = 0.283, p = .868$. Overall, model five was both the best fit and a good fit. The root mean square error of approximation (RMSEA) steadily decreased from .692 to < .001, suggesting that model five was the best fit, and an excellent fit (MacCallum et. al., 1996), and the SRMR continuously decreased from 0.527 to 0.003, indicating that model five was an excellent fit. The comparative fit index (CFI) increased from 0.00 to 1, suggesting model 5 was a good fit ($> 0.95$) (Hu & et. al., 1999). Across models the residuals decreased, as the error variance moved into the intercept and variance and slope means.
Table AH.2.

Comparison of model fits for immediate choice ratios.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>996.71</td>
<td>307.93</td>
<td>307.93</td>
<td>24.66</td>
<td>0.34</td>
</tr>
<tr>
<td>RMSEA</td>
<td>.69</td>
<td>.41</td>
<td>.45</td>
<td>.16</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>SRMR</td>
<td>.53</td>
<td>.15</td>
<td>.15</td>
<td>.06</td>
<td>.003</td>
</tr>
<tr>
<td>CFI</td>
<td>&lt; 0.001</td>
<td>0.68</td>
<td>0.68</td>
<td>0.98</td>
<td>1</td>
</tr>
<tr>
<td>Residuals</td>
<td>.05</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
<td></td>
</tr>
</tbody>
</table>

Condition did not effect the mean value of linear slopes, $b = 0.003$, $SE_b = 0.002$, $z (295) = 0.94$, $p = .35$, 95% CI [- 0.004, 0.01]. Religiosity did not predict the mean value of linear slopes, $b = - 0.002$, $SE_b = .001$, $z (295) = - 1.41$, $p =.16$, 95% CI [- 0.01, 0.001]. As seen in Figure AH.2., the mean value of linear slopes showed a slight decrease in immediate choice ratios (ICR) from small over medium to large rewards participants who prayed, moderated by religiosity, $b = - 0.003$, $SE b = 0.001$, $z (295) = -2.00$, $p = 0.05$, 95% CI [- 0.01, 0.001], controlling for socioeconomic status.
Figure AH.2. Latent growth model showing religiosity’s moderation of prayer’s effect on changes in immediate choice ratios between small, medium, and large rewards, controlling for socioeconomic status.
Appendix I

Swahili intuitive translation quiz

Often we can intuit the meaning of words even if we are not familiar with a language. Below are the names for some common nouns in Swahili. Try to figure out what these words mean in English, using only your intuition. Write your guess in the blank space provided. **The participant(s) with the highest score will win a bonus $100.** Good luck!

<table>
<thead>
<tr>
<th>Swahili</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>chungwa</td>
<td></td>
</tr>
<tr>
<td>chupa</td>
<td></td>
</tr>
<tr>
<td>daraja</td>
<td></td>
</tr>
<tr>
<td>dawati</td>
<td></td>
</tr>
<tr>
<td>kiatu</td>
<td></td>
</tr>
<tr>
<td>kikombe</td>
<td></td>
</tr>
<tr>
<td>kitanda</td>
<td></td>
</tr>
<tr>
<td>kitanda</td>
<td></td>
</tr>
<tr>
<td>maembe</td>
<td></td>
</tr>
<tr>
<td>mamba</td>
<td></td>
</tr>
<tr>
<td>mchoro</td>
<td></td>
</tr>
<tr>
<td>mti</td>
<td></td>
</tr>
<tr>
<td>mwavuli</td>
<td></td>
</tr>
<tr>
<td>nanasi</td>
<td></td>
</tr>
<tr>
<td>nanga</td>
<td></td>
</tr>
<tr>
<td>ngoma</td>
<td></td>
</tr>
<tr>
<td>nyumba</td>
<td></td>
</tr>
<tr>
<td>viatu</td>
<td></td>
</tr>
</tbody>
</table>
Appendix J

Hurdle model comparisons

Part 1 of model 1, a truncated Poisson with a log link, suggested that prayer decreased rates of positive values for cheating, $b = -0.17$, $SE_b = 0.05$, $z(231) = -3.81$, $p < .001$. Religiosity predicted positive cheating counts, $b = 0.10$, $SE_b = 0.02$, $z(231) = 5.04$, $p < .001$, and religiosity moderated prayer’s effect on cheating rates, $b = 0.07$, $SE_b = .02$, $z(231) = 3.88$, $p < .001$, with prayer increasing cheating rates as religiosity increased. An overall positive view of God predicted a decrease in positive cheating values, $b = -0.06$, $SE_b = 0.02$, $z(231) = -3.50$, $p < .001$.

Part 2 of model 1, a binomial with logit link, showed that prayer did not affect the probability of participants cheating or not cheating (crossing the hurdle), $b = 0.01$, $SE_b = 0.14$, $z(231) = 0.10$, $p = .92$. Religiosity predicted whether participants cheated or not, $b = 0.11$, $SE_b = 0.06$, $z(231) = 1.98$, $p = .05$, with the probability of cheating increasing as religiosity increased. Religiosity moderated prayer’s effect on whether participants cheated or not, $b = -0.12$, $SE_b = 0.05$, $z(231) = -2.22$, $p = .03$. Positive views about God did not predict whether participants cheated or not, $b = -0.09$, $SE_b = .06$, $z(231) = -1.5$, $p = .13$.

The second model, a hurdle model with a truncated negative binomial distribution with log link, showed that condition marginally, but not significantly, decreased positive values for cheating, $b = -0.28$, $SE_b = 0.16$, $z(231) = -1.74$, $p = .08$. Religiosity predicted an increase in positive cheating counts, $b = 0.16$, $SE_b = 0.07$, $z(231) = 2.28$, $p = .02$. Religiosity slightly moderated prayer’s marginal effects on positive cheating counts, $b = 0.12$, $SE_b = 0.07$, $z(231) = 1.74$, $p = .08$. Positive views about God did not predict positive cheating counts, $b = -0.08$, $SE_b = 0.06$, $z(231) = -1.28$, $p = .20$.

Part 2 of model 2, a binomial with logit link, showed that condition did not predict whether
participants cheated or not, $b = 0.01$, $SE_b = 0.136$, $z$ (231) = 0.1, $p = .921$. Religiosity predicted whether participants cheated or not, $b = 0.111$, $SE_b = 0.056$, $z$ (231) = 1.984, $p = .047$. Religiosity moderated prayer’s effect on cheating, $b = -0.115$, $SE_b = 0.052$, $z$ (231) = -2.221, $p = .026$, with prayer decreasing the probability of participants cheating or not as religiosity increased. Positive views about God did not predict whether participants cheated or not, $b = -0.088$, $SE_b = 0.059$, $z$ (231) = -1.5, $p = .134$.

The two models’ relative fit was compared using Akaike information criterion (AIC). Bayesian information criterion (BIC), log likelihood, Vuong tests (Vuong, 1989), and rootograms (Zeileis & Kleiber, 2016). Model 1 had a larger AIC value (1113.724) and a larger log-likelihood (-546.9) than Model 2 (845.76; -411.9), indicating poorer fit. Model 1 (1148.148) had a larger BIC than model 2 (883.627). Vuong tests compared the models, with a Vuong test statistic of -6.47, and $p < 0.01$, under the null hypothesis that the models were equivalent; Model 2 was a significantly better fit to the data than model 1. In addition, Wald test statistics revealed that model 2 was a significantly improved fit to the data over model 1, under the null hypothesis that the two models were indistinguishable, $x^2 = 269.96$, $p < .0001$.  

Table AJ.1.

*Hurdle model comparisons.*

<table>
<thead>
<tr>
<th></th>
<th>Model 1: Hurdle (truncated Poisson)</th>
<th>Model 2: Hurdle (truncated NB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>count</td>
<td>zero</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>1.84***</td>
<td>-0.047</td>
</tr>
<tr>
<td>condition</td>
<td>-0.17***</td>
<td>0.01</td>
</tr>
<tr>
<td>religiosity</td>
<td>0.10***</td>
<td>0.11*</td>
</tr>
<tr>
<td>cond*religiosity</td>
<td>0.07***</td>
<td>-0.12*</td>
</tr>
<tr>
<td>positive view of God</td>
<td>-0.06***</td>
<td>-0.09</td>
</tr>
<tr>
<td>Log (theta)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>231</td>
<td>231</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-546.9 (10)</td>
<td>-411.9 (11)</td>
</tr>
<tr>
<td>AIC</td>
<td>1113.72</td>
<td>845.76</td>
</tr>
<tr>
<td>BIC</td>
<td>1148.15</td>
<td>883.63</td>
</tr>
</tbody>
</table>

\[ p < .05^{*} , .01^{**} , .001^{***} \]
As seen in the hanging rootogram (Figure AJ.1.), model 1 appears to be a poorer fit, overall, than model 2. Model 1 perfectly fits the zero counts and nearly fits the 12 and 14 counts. It under predicts counts 1, 2, 13, 15, 16, and 17 counts and over predicts counts 3-11. In contrast, model 2 perfectly or near perfectly fits the zero, one, two, five, ten, 12, 14 and 15 counts. It under predicts counts 13, 16, and 17 counts. Model 2 slightly over-predicts counts three, four, six, seven, eight, and nine counts and substantially over-predicts count 11. While model two is preferable to model one, over-dispersion seems equally problematic in both models, as seen in the sixteen and seventeen counts, despite the allowances made by a negative binomial distribution over a Poisson distribution.

Zeiles & Kleiber (2016) recommend the hanging rootogram as it illustrates discrepancies between observed and expected counts. The red line reflects expected counts. The grey bars show observed counts. The zero line represents the reference line for fit. The x-axis reflects the cheat count bin and the y-axis shows the SQRT of the observed and expected counts.
Figure AJ.1. Rootogram assessment of goodness of fit, comparing observed and expected counts.
Appendix K

Hurdle model analysis R code.

#load packages
library(pscl)
library(memisc)
library(lmtest)
library(aod)
library(MASS)
library(AIC)
library(countreg)
library(boot)

#plot data
plot(table(cheat_count))

#hurdle model poisson distribution
model1 <- hurdle(cheat_count ~ Cond * SBS_centered + VOG, data = Study6, dist = "poisson", zero.dist = "binomial", link = "logit")

#hurdle with negative binomial distribution
model2 <- hurdle(cheat_count ~ Cond * SBS_centered + VOG, data = Study6, dist = "negbin", zero.dist = "binomial", link = "logit")

#draw and compare models countreg, ggplot2, cowplot, gridextra
library(countreg)
library(cowplot)
library(gridExtra)
library(ggplot2)

#compare graphs
root.model2 <- rootogram(model2, max = 18)
root.model1 <- rootogram(model1, max = 18)
ylims <- ylim(-2, 7)
autoplot(c(root.model1, root.model2))
# aic
AIC(model1)
AIC(model2)

# vuong
vuong(model1, model2)

# partial wald test
coeftest(model2)

# number of parameters
length(coef(model2))

# 95% CI of odds ratio,
exp(confint(model2))

# positive counts odds
exp(0.16378)
# zero counts odds
# odds ratio for sbs
exp(0.11052)
# odds ratio cond
exp(0.01357)
# odds ratio for cond*sbs
exp(-0.11538)

# compare predictions to sums
sum(cheat_count < 1)
sum(predict(model1, type = "prob")[,1])
sum(predict(model2, type = "prob")[,1])
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