

HOLY DAY EFFECTS ON LANGUAGE: HOW RELIGIOUS GEOGRAPHY,
INDIVIDUAL AFFILIATION AND DAY OF THE WEEK RELATE TO
SENTIMENT AND TOPICS ON TWITTER

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DISSERTATION ABSTRACT

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Title: Holy Day Effects on Language: How Religious Geography, Individual Affiliation and Day of the Week Relate to Sentiment and Topics on Twitter

Religious belief and attendance predict improved well-being at the individual level. Paradoxically, geographic locations with high rates of religious belief and attendance are often those with the differentially high rates of societal instability and suffering. Many of the consequences of religiosity are context-based and vary across time, and holy days are naturally-occurring religious cues that have been shown to influence religiously-relevant attitudes and behaviors. I investigated the degree to which personal religiosity and religious geography (i.e. religious demographics with other location variables) individually and interactively predict well-being across days of the week.

In the first study, American Christians demonstrated greater well-being by expressing more positive sentiment in Twitter posts, while American Muslims displayed less well-being. Sundays were generally the most positive day, but American Muslims communicated more happiness on Fridays (the Muslim holy day). In the second study, Christianity did not predict increased well-being in the posts of college students. In the third study, global survey data with measures of religiosity and well-being indicated that the well-being consequences of religious

affiliation depend on the religious group and location, and that people tend to be especially positive on their group's holy day. Study four explored the latent topical content of Twitter posts. Across studies, religious minority status appeared to have a deleterious effect on well-being.

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CHAPTER I

INTRODUCTION

Religious belief and attendance are robustly correlated with measures of well-being (e.g. Witter, Stock, Okun & Haring, 1985). At the individual level, religiosity predicts health and happiness. Religious believers not only report greater happiness and health – measures of subjective well-being (e.g. Green & Elliott, 2010) – they tend to fare better on objective measures of well-being as well; religiosity protects against morbidity and mortality (Ellison & Levin, 1998; Powell, Shahabi & Thoresen, 2003). Religious belief, and particularly religious service attendance, apparently help individuals live longer, healthier, happier lives.

The mechanisms underlying the well-being benefits of religiosity are numerous. Religious beliefs promote healthy behaviors (Ellison & Levin, 1998; Miller & Thorensen, 2003). Taboos against alcohol and drug use, sexual promiscuity, and even pork consumption lower disease risk. Religious communities provide extensive and uniquely cohesive social support. Adequate social support promotes psychological well-being in its own right, and being embedded within supportive communities also allows sick individuals to heal faster. Religious beliefs provide coping mechanisms and lead to positive emotions. Though measurement techniques and, to some extent, proposed mechanisms separate psychological and subjective well-being from objective health status, these are inter-connected and strongly correlated. Happiness is bi-

directionally related to health status and longevity. Well-being is a broad, multifaceted construct, that is nonetheless quite coherent in its causes and consequences, so I make few distinctions between various measures of well-being for the purposes of this dissertation.

Well-being in religious places

Despite the associations between religious belief and religious service attendance with individual well-being across measures, a paradoxical relationship exists between religious places and well-being. Places with low rates of religious belief are relatively prosperous, while there is generally more suffering in places with high rates of religious belief. Whether this relationship is causal, and in what direction, is not well understood, but the relationship between societal conditions and religiosity has been the source of study and speculation.

In the U.S., states with the highest rates of religiosity are among the most miserable and unhealthy (e.g. Gray & Wegner, 2010). Gray and Wegner (2010) calculated a “suffering index” by reversing the United Health Foundation’s health index, which ranks states based on rates of violent crime, infant mortality, cancer deaths, infectious disease, and environmental pathogen loads. There was a strong correlation between this measure of suffering and the share of state populations that report strong belief in God, even after accounting for race and GDP per capita. Gray and Wegner contend that religions thrive in areas where suffering is common due to humans’ predisposition to infer a responsible agent as the source of suffering, so that God is evoked more frequently in places where suffering is

common, which strengthens belief. This view is aligned with Terror Management Theory. In places where death is relatively common and salient, people have more motivation to invest in death transcendence beliefs, like those provided by religions (Jonas & Fisher, 2006).

The paradoxical relationship between individual religiosity, religious geography and well-being has been demonstrated on a global scale as well (Diener, Tay & Myers, 2011). Across four major religious groups and throughout the world, religious individuals report higher subjective well-being, but countries with the most misery (lack of safety, minimal educational or economic opportunities, widespread hunger, low life expectancy, etc.) also have the highest rates of religiosity, based on questionnaire measures of religious salience and attendance. In more stable and prosperous nations around the world, people are less religious, and individual religiosity is less or unrelated to personal subjective well-being.

Well-being of religious minority members

Diener et al. (2011) explain these findings by proposing that people in relatively well-off, flourishing societies have their needs for social support, respect and meaning met without having to rely on religious beliefs or communities, and thus benefit from religion to a lesser extent. Since the authors' explanatory mechanism for religion's prevalence and positive influence in promoting subjective well-being is through the fulfillment of needs for belonging and respect, examining relative well-being based on religious minority or majority status would be expected to demonstrate that religious majority

members benefit more than minorities, particularly in cases of extreme or denigrated minority groups. Members of minority groups often experience higher stress and lower well-being than others, due to prejudice and discrimination (e.g. Harrell, 2000; Meyer, 2003). Smaller religious flocks, fewer opportunities to attend religious services and community events, fewer reminders of religious belief and belonging, and less respect toward religious minority groups would be expected to diminish the effectiveness of religion as a means of increasing well-being in difficult places.

Well-being at religious times

The “Sunday effect” is a temporary shift in religiously relevant attitudes or behaviors due to the salience of religious concepts on Sundays (Malhotra, 2010). The Sunday effect has been demonstrated online using measures of charitable giving and pornography consumption – activities that religious individuals report doing significantly more (e.g. Brooks, 2003) and less of (Stack, Wasserman & Kern, 2004), respectively.

Malhotra (2010) collaborated with an online auction website to manipulate messages sent to users to notify them that they had been outbid. One of the messages encouraged users to rebid by emphasizing the competitive nature of online auctions. The other message appealed to charity, saying: “We hope you will continue to support this charity by keeping the bidding alive. Every extra dollar you bid in the auction helps us accomplish our very important mission.” Importantly, auctions benefiting religious charities were not included in the study. Users also completed questionnaires, including a measure of religious

attendance. Users who described themselves as regular Sunday church-attenders were differentially likely to rebid after receiving an appeal to charity on Sundays. On every other day of the week, religiosity did not increase charitable donations through the auction website. In fact, non-religious users were slightly more likely to bid again after receiving a message appealing to charity on other days. These results indicate that, while religious individuals may be no more generous at baseline, the salience of religion on Sundays, and the act of church attendance correspond to a short term increase in prosocial giving.

Pornography is often seen as socially undesirable, and its consumption is therefore under-reported, especially among the religious (Leak & Fish, 1989). Using credit card billing zip codes shared by a prominent seller, Edelman (2009) analyzed new subscriptions to pornographic websites by state. Disproportionately few subscriptions came from states with high levels of church attendance on Sundays, but there was no overall effect of state religiosity on pornography consumption. In states with high rates of church attendance, people appeared to compensate for their holy day reprieve throughout the rest of the week.

Other attitudes and behaviors associated with religiosity are similarly ephemeral and context-dependent. For example, all world religions emphasize prosociality, but generosity, cheating and revenge-taking seem to be readily manipulated with experimental primes of religion. Shariff and Norenzayan (2007) found that participants who unscrambled sentences with religious content (words like “spirit,” “divine,” “God,” and “sacred”) shared more money with anonymous others in a dictator game that followed than those who unscrambled

sentences with neutral content. Randolph-Seng and Nielsen (2007) reported that religious primes decreased cheating behavior among religious believers, though individual religiosity alone did not influence cheating. And Saroglou, Corneille and Van Cappellen (2009) demonstrated that individuals subliminally primed with religious words were more likely to acquiesce to an experimenter's suggestion to take revenge on a fellow participant. The authors theorized that religious contexts increase conformity and submissiveness. In each of the above studies, dispositional religiosity was less or unrelated to behaviors expected to be related to religious belief and training than the experimental manipulations that introduced religious context.

It may be that religiosity's relation to happiness follows weekly and other temporal patterns as well. There is some evidence that religious times are happier times. Individuals receive short-term happiness boosts from attending religious services, across affiliations (Mochon, Norton & Ariely, 2008). Despite persistent myths to the contrary, suicides are most common in Spring, are rare in Winter (despite seasonal depression), and occur at especially low rates on major religious holidays (Gabennesch, 1988). Reminders of religious beliefs and norms during naturally-occurring primes of weekly holy days and religious holidays may prompt religious individuals to feel happier, or to at least report being happier, since being positive, compliant and self-enhancing are religiously relevant. Religious attendance is especially correlated with measures of well-being, likely due, at least in part, to the positive influences of social bonds and opportunities to commune with the religious ingroup.

Well-being throughout the week

Based on what is understood about religiosity in general and religious attendance in particular, it follows that religion's association with happiness may vary based on temporal patterns of religious context and availability of coreligionists, and this is supported by some previous research. According to a Gallup poll of about 330,000 American adults (2011), frequent church attenders (those who attend "at least once a week") experience the greatest number of positive emotions and the least number of negative emotions on Sundays, compared to all other days of the week *and* to individuals who attend church less frequently or not at all. Overall well-being, based on self-reports of positive and negative emotionality, was higher in regular church attenders (those who attend at least "about once a month") overall, compared to those who attend church seldom or never. However, the well-being boost on Sundays was only apparent in those who report attending *at least* weekly. People who attend almost every week or less frequently either showed no difference compared to Saturday, or experienced the most positive and least negative emotion on Saturdays, followed by a marked dip in well-being on Sundays. Sundays were still more positive than non-weekend days across religious attendance groups, demonstrating a weekend effect on emotionality. Perhaps unsurprisingly, most people report being happier during the weekend.

Religious personalities and well-being

Complicating, but possibly explaining some contradictory findings in the study of religiosity and well-being across stable and difficult life circumstances,

are associations between personality and religiosity. Individual religiosity is associated with dispositional factors that are also related to measures of subjective well-being. Specifically, religious belief is modestly but reliably correlated with agreeableness (meta-analytic $r = 0.2$, range .06 - .41) and conscientiousness (meta-analytic $r = .17$, range .08 - .27) (Saroglou, 2002). Agreeable people are characterized by tendencies to be likeable and compliant (e.g. McCrae & Costa, 1999). Among other things, conscientiousness is associated with conforming to social norms.

The relationship between personality factors and religiosity is likely bidirectional (McCullough & Willoughby, 2009). Having dispositional tendencies to be nice and conform to social norms would encourage religiosity in most contexts, since most people around the world are religious. Religions also have features that encourage the development of agreeableness and conscientiousness. Religious individuals are obligated to follow rules and may develop better self-control, and religiosity may influence and facilitate goal selection and pursuit. Religious believers are also scrutinized by moral community and supernatural audiences, leading to increased self-monitoring and, often, self-enhancement (Sedikides & Gebauer, 2009). Religious individuals consistently self-enhance, misleading researchers to portray themselves in a dishonestly positive way, both intentionally and unconsciously, to a larger degree than the non-religious.

Self-report measures of subjective well-being, such as assessments of positive and negative affect and life satisfaction, are moderately correlated with agreeableness and conscientiousness (Diener, Suh & Oishi, 1997). While it makes

intuitive sense that people who possess these traits might lead happier lives than people without them, and the relationship between these personality variables and subjective well-being tend to be longitudinally stable regardless of difficult life changes (Costa, McCrae & Zonderman, 1987), the particular traits correlated with religiosity warrant some level of skepticism regarding self-reports of satisfaction and affect. Reports of positive feelings and relatively high life satisfaction are nicer, in line with social norms and more consistent with dispositional self-enhancement than reports of negative emotions and dissatisfaction to researchers. That is, religious individuals may be more likely to say that they are happy and satisfied for social reasons, regardless of their private assessments of their well-being.

Computational methods for assessing well-being

Further, reports of religious attendance might overlap with reports of well-being simply because both are self-enhancing. Church attendance is consistently over-reported in contexts where religiosity is normative (e.g. Hadaway, Marler & Chaves, 1998; Brenner, 2011). While about 40% of Americans claim to attend weekly religious services, estimates based on head counts within places of worship indicate that only about 22% attend weekly (Hadaway & Marler, 2005). When religious attendance is coded based on participant time diaries, about 24% are coded as weekly attenders (Brenner, 2011). It seems likely that some of the participants who artificially inflate their religious attendance inflate other aspects of their reports as well. After all, surveys tend to measure how people see and present themselves better than the objective frequency of behaviors. This is

especially true when the behavior in question is subject to strong social desirability bias. Since both religious personalities and religious content in surveys increase the incidence of misleading self-enhancements, measuring the effect of religiosity and religious service attendance on well-being using self-report methods alone can be particularly problematic.

Emergent computational techniques provide a way of avoiding the particular limitations and potential for systematic overestimates in measuring religiosity and well-being through self-reports, in addition to the expense of obtaining large, nationally representative samples to collect them. Sentiment analysis is a particularly promising avenue for studying well-being in a naturalistic, completely unobtrusive way. Using geotagged tweets to make comparisons at the state and urban area levels, Mitchell, Frank, Harris, Dodds and Danforth (2013) established that positive language on Twitter correlates to other, more established measures of well-being. At the state level, happiness in tweets correlated positively with Gallup's well-being data, the Peace Index (2011) and the Behavioral Risk Factor Surveillance System's survey data (2005 – 2008), and negatively with rates of gun violence. Correlations between traditional surveys and tweets were mixed at the city level. As an exploratory step, Mitchell et al. also examined the content of tweets using single word frequency correlations to education and obesity, predictors of well-being. Quercia, Ellis, Capra and Crowcroft (2012) used Linguistic Inquiry and Word Count (LIWC) and maximum entropy techniques of sentiment analysis and verified that positive emotions in tweets correlated with measures of socioeconomic well-being in

London, and suggest that monitoring sentiment in tweets is an effective way of estimating community well-being, either as a compliment to traditional survey methods, or as a stand-alone approach.

Ritter, Preston and Hernandez (2013) analyzed sentiment using LIWC by religious affiliation on Twitter by sampling from the followers of prominent Christian and prominent atheist accounts, and reported that Christians in their sample were happier. A potential limitation of their sampling approach is that atheists and Christians who follow those accounts may not be representative of atheists and Christians overall, and, perhaps more importantly, recent research by Haushofer and Reisinger (2017) demonstrated that exposure to emotional atheist messages popularized by “New Atheists” – the prominent atheists on Twitter – decreased self-reported subjective well-being. Since exposure to the content of those specific atheist accounts decreases well-being experimentally, confounding atheism with account exposure may be a misleading way to measure the well-being effects of dispositional atheism. A comparison of sentiment using different sampling methods may clarify these relationships.

Pilot studies

To measure fluctuations in well-being throughout days of the week and their relation to personal and contextual religiosity, I conducted pilot studies with sentiment analyses of tweets. Tweets are brief posts on Twitter, a popular micro-blogging platform. Twitter boasts more than 300 million active monthly users all over the world (Twitter, 2016), and is primarily used to express emotions and opinions (Pak & Paroubek, 2010). Twitter profiles and posts tend to be available

to the public, rather than restricted to users' friends and acquaintances, and the brevity of posts imposed by Twitter's 140 character limit requires users to choose language and distill thoughts carefully. Tweets can be collected and analyzed without user awareness, eliminating participant burden and providing more ecological validity than some other measures. For these reasons, Twitter data seemed well-suited for analyses of well-being, using emotional positivity as a proxy for happiness, between users of different religious affiliations, within and between geographic locations with different levels of religiosity and suffering, and across days of the week.

LIWC

A variety of methods are available for sentiment analysis, but Linguistic Inquiry and Word Count (LIWC; Pennebaker, Chung, Ireland, Gonzales & Booth, 2007) has been used most commonly in psychological research. Lexical/dictionary approaches such as LIWCs typically perform better and are easier to conduct and explain than n-gram methods of sentiment analysis, and computational methods have the advantage of being drastically faster than methods relying on human coders. A disadvantage of LIWC is that it is a closed source, proprietary software, so some mechanisms underlying its functions are opaque to users. The LIWC user interface offers many categories for topic and sentiment analysis. In pilot studies, I analyzed tweets for sentiment using LIWC's positive emotion category, which scores each tweet for whether and how much positive emotion it communicates. Levels of happiness based on religious affiliation had been measured and reported using LIWC's positive emotion results for tweets by

Ritter, Preston and Hernandez (2013), and happiness in tweets corresponds to established measures of well-being at the aggregate-level (e.g. Quercia et al., 2012; Mitchell et al., 2013), but individual and place-level religiosity's relationships to sentiment in tweets had not previously been studied side-by-side to my knowledge.

Pilot study 1

I first tested for a Sunday effect on happiness based on individual user religiosity. Tweets, user and metadata were collected from North American time zones via Twitter's public streaming application programming interface (API). Tweets (in English only) were scored for happiness using LIWC's positive emotion category. User religious affiliation was coded based on the presence of "Christian" or "Muslim" in user descriptions of Twitter profiles.

In the overall corpus of tweets ($N = 29,918$), there was no relationship between day of the week and happiness. Self-identified Christian and Muslim users, however, demonstrated increased happiness on their respective holy days with an affiliation by day interaction ($N = 381$, $t = 3.54$, $p < .001$). Thus, the "Sunday effect" on happiness appears to vary based on religious affiliation, and is better understood as a holy day effect.

Pilot study 2

Pilot study 1 focused on self-identified Christians and Muslims, but users rarely self-identify as belonging to a particular religion in their Twitter profile description fields. It is more common for users to submit their geographic

location in the location field of their Twitter profiles. To assess happiness as a function of religious geography, I compared tweets from states with the highest rates of church attendance (Utah, Mississippi, Alabama, Louisiana, Arkansas and South Carolina) to states with the lowest rates of attendance (Vermont, New Hampshire, Maine, Massachusetts, Washington and Oregon) (Gallup, 2015). State-level church attendance is correlated negatively with subjective well-being in general, perhaps due to differential suffering discussed above (Gray & Wegner, 2010). This negative relationship was apparent within this Twitter sample, except on Sundays. Expressed happiness in the highest attendance states only exceeded low attendance states on Sundays, with marginal significance ($N = 322$, $t = 1.68$, $p < .1$), possibly demonstrating the power of church attendance to increase happiness temporarily.

Current Investigation

Pilot studies provided preliminary support for my hypotheses that well-being is temporarily boosted on holy days among religious believers and in religious places. However, due to the reliance on users to self-identify their religious affiliation and location, the number of tweets analyzed for interactions was small, and comparisons were only made between Christians and Muslims, users in the very highest and very lowest attending states, on holy days and all other days. These results corroborated previous work on the paradoxical associations between personal religiosity, religious geography and well-being in that Twitter users in the most religious states were less happy than those in the least religious states, except on Sundays.

Though differences in quality of life present a theoretically compelling and ostensibly empirically supported explanation for lower well-being in states with high rates of religious attendance, there may be equally valid alternative explanations. For example, frequent religious attendance could increase intergroup conflict, with a variety of churches and congregations competing with each other. There is wide variability in belief structures and priorities, even within American Christianity. A recent survey found that half of American adults reported seeking a new church, and 30% of those reported that a conflict with clergy or church members, or some other social or practical reason (aside from marriage, divorce or relocation) inspired them to leave their previous congregation (Pew Research Center, 2016). This source of stress is uncommon in states with low rates of church attendance. Most states analyzed in pilot study 2 in the high attendance category also happen to be those with cultures of honor, and cultures of honor are characterized by outbursts of negative emotionality (Cohen, Nisbett, Bowdle & Schwarz, 1996).

The studies in this dissertation sought to minimize cultural confounds in the connections between religious geography and happiness and dig into majority/minority religious status as a possible mediator by expanding the geographic scope and methods used to assess patterns in individual religiosity, religious geography, day of the week and well-being. I replicated pilot studies with larger samples and classification techniques, expanded cross-nationally, and included surveys, both as a compliment to sentiment analysis of tweets, as in study 2, and as a stand-alone method of assessing interactions between religious

geography, religious affiliation, day of the week and reported well-being, as in study 3.

CHAPTER II

STUDY 1 METHODS

Tweets were collected, with meta-data, from Twitter's public streaming API using the tweepy package in Python 3. Both the data source and collection mechanism are free and open source. This approach has the disadvantage of oversampling frequent Twitter users, and therefore does not provide a random sample of all individuals with Twitter accounts. Raw JSON data were parsed into rows representing observations and columns representing potentially relevant fields (date created, text, user identification number, user reported location, user description, user name, screen name, time zone, language, and friends count) using the streamR package in R. Observations were dropped if they represented deletions, rather than new tweets, and if they did not meet the following inclusion criteria:

- 1) From a user account in either English or Arabic
- 2) From a user account in either U.S. (Hawaii, Pacific Time, Mountain Time, Central Time, or Eastern Time) or Egypt (Cairo) time zones
- 3) The first observation collected from a unique user account (only one tweet per account was analyzed)

The resulting data frame contained 7,160,443 tweets.

Classifying tweets by U.S. state

Tweets and accounts were coded for U.S. state based on user-provided location data. A variable was created to code Gallup's (2015) ranking of a state's religious attendance on a scale of 1 – 51 (Gallup included the District of Columbia), with 1 being coded for any tweet with either “Utah”, or “UT” in the user location field, since Utah is the most frequently attending state. There were 1,586,683 tweets from accounts with mentions of a state (but not two or more), in English and from U.S. time zones. The first 1,048,574 of these were analyzed for tone in LIWC.

Classifying users by religious affiliation

The meta-data collected with tweets was used to code some tweets as likely belonging to a Christian, Muslim or atheist. I used two methods to identify users by affiliation, and flagged accounts that indicated any affiliation by coding “1” in any of six dummy variables (three affiliation categories x two methods).

Detecting self-identification with a religious group

Tweets were flagged as belonging to self-identified Christians, Muslims or atheists respectively if the stem “Christ”, “Muslim” or “atheist” appeared in the user description field of the corresponding Twitter profile. None of the user descriptions contained stems from two or more affiliation groups.

Identifying users by accounts followed

According to previous research, we can reasonably infer that users who follow certain accounts (see Table 1) also affiliate with a certain religious group, since these accounts are rarely followed by users without the corresponding affiliations due to their content (Chen, Weber & Okulicz-Kozaryn, 2014).

The user identification numbers for followers of the 45 most discriminative accounts by religious affiliation were collected from Twitter's public rest API. Unlike Twitter's streaming API, which allows collection of a random sample of tweets with limited metadata from the users' profiles, in real time, the rest API allows researchers to collect comprehensive details on a myriad of aspects of specific accounts. All follower identification numbers were scraped, except in cases when an account had over 4 million followers. In those cases, the first 4 million identification numbers were collected, due to limitations imposed by Twitter's terms of service for developer accounts. The accounts indicative of Christian affiliation had 20,725,929 followers collected. The Muslim accounts had 9,670,274 combined followers. The accounts suggesting atheism had 19,661,550. It is likely that there is some overlap within affiliation. That is, followers of Bill Nye might also follow Neil Degrasse Tyson, and the above counts are not deduplicated. These collected user account numbers were compared to those in the streaming dataset, and matches were flagged, with new variables for each affiliation.

Of the 7,160,443 accounts that met the inclusion criteria (tweeting in Arabic or English from the U.S. or Egypt), only 12 followed any of the 15 most

discriminative Muslim accounts, and 3 followed any of the 15 most discriminative Christian accounts. None of the accounts analyzed followed any of the 15 most discriminative atheist accounts. Zero users followed accounts from more than one discriminative account group, and none of the followers in the dataset had self-identified as a member of a religious group or as atheists. Collecting followers of discriminative accounts was intended to increase sample size and produce a more diverse sample than in the pilot study, since it seems likely that users who identify their religious affiliation within their Twitter user descriptions are not representative members of those groups. The number of users collected through the streaming API who happened to be followers of any of the top discriminative accounts was lower than previously assumed.

In total, including those identified by either self-identification in profiles or by follower status, 50,236 accounts were classified as belonging to a Christian, Muslim, or atheist, and the user data and tweets. These tweets with account data were saved for further analyses.

The text of tweets classified as belonging to either a Christian, Muslim, or atheist in a U.S. time zone were analyzed for sentiment using the most recent version of Linguistic Inquiry and Word Count (LIWC, 2015). Though the pilot studies utilized LIWC's positive emotion scores, well-being is characterized not only by the presence of positive affect, but also by the absence of negative affect (Diener, Suh & Oishi, 1997). Thus, tweets in study 1 were analyzed for Tone: LIWC's proprietary composite category that rates each segment of text on a 0 – 100 scale, with low scores indicating negative emotionality, high scores indicating

positive emotionality, and moderate scores indicating ambivalent or flat emotional tone.

CHAPTER III

STUDY 1 RESULTS

Tone in tweets was analyzed for day of the week and religious influences based on individual affiliation, religious geography, and minority/majority religious status.

State-level church attendance and tone

Every state was represented. The number of observations per state ranged from 1,429 users, in Wyoming, to 139,917 users in California. Tweets were not collected equally across days of the week, and in this set the number of tweets per day ranged from 27,189 captured on Thursdays to 349,549 captured on Wednesdays. A Bartlett test indicated that the widely disparate number of observations per day created a degree of heterogeneity that violated the statistical assumptions underlying linear regression ($K^2(6) = 31.67, p < .001$). To solve this, a sampling weight variable was created to reweight the data, such that each observation from a Thursday counted as one, but each Wednesday as .08 and so on, until the sample was balanced by day. The following linear model was weighted, satisfying the necessary statistical assumptions.

The mean tone was 43.73, with a standard deviation of 35.44 and a range of 0 – 99. The weighted mean (accounting for the unequal number of tweets across days of the week) was 43.57, with a standard deviation of 35.42. Tone scores were entered into a linear regression model with day of the week, state

religious attendance rank and their interactions as predictors, weighted by the sampling weight variable.

State-level religious attendance was predictive of tone in tweets, such that states with lower levels of religious attendance (ranked with higher numbers) were more positive overall ($b = .04$, $SE = .01$, $t(1,048,560) = 5.64$, $p < .001$). Most days of the week were significantly different from others, and Sundays were the most positive day (see table 3). However, the only significant interaction between day of the week and state religious attendance occurred on Saturdays, when states with lower levels of religious attendance were less positive ($b = -.02$, $SE = .01$, $t(1,048,560) = -2.51$, $p < .05$).

Religious affiliation and tone

Tweets originating from a U.S. time zone and flagged as likely belonging to a Christian, Muslim or atheist ($N = 49,153$) were analyzed for tone with LIWC. There were three followers of Christian accounts and 42,475 self-identified Christians, 12 Muslim account followers and 4,417 self-identified Muslims. There were 2,458 self-identified atheists. There was no overlap between these categories of religious identification.

A Bartlett test of homogeneity of variances indicated that the drastic differences in religious group sizes were likely problematic ($K^2(2) = 74.35$, $p < .001$). A sampling weight was created to balance user religious affiliation, such that every atheist tweet was weighted as 1, every Muslim as .55 and every

Christian tweet as .06. This sampling weight solved the problem and was used in the following linear model.

The tweets in this set were also collected unevenly throughout the week, with a range of 2231 (Monday) to 9862 (Friday) collected per day. A Bartlett test and visual inspection of residuals did not indicate that this imbalance was problematic for modeling ($K^2(6) = 1.02, p = .98$), so no weighting or other action was taken to address this sampling imbalance.

The unweighted mean was 44.82, with a standard deviation of 36.25, and the weighted mean (accounting for the disproportionate share of Christians in the data) was 42.05, with a standard deviation of 35.28. Means and standard deviations for each religious affiliation by day of the week are presented in table 7.

Christians and Muslims, the two groups of primary interest across studies, were analyzed first, along with all days of the week, and the interactions between Christian and Muslim affiliation and Sundays and Fridays, the respective holy days of each group. The overall model predicted sentiment in tweets, though the effect size was small ($R^2 = .0058, F(12, 49140) = 23.88, p < .001$). With all days of the week entered into the model as factors, only Fridays significantly predicted tone in tweets. Tweets were more negative on Fridays ($b = -1.58, SE = 0.79, t(49,140) = -1.98, p < .001$). As predicted, Christian religious affiliation was associated with more positive tone in tweets ($b = 4.65, SE = 0.47, t(49,140) = 9.81, p < .001$), and Muslim affiliation was associated with more negative tone ($b = -1.33, SE = 0.49, t(49,140) = 2.69, p < .001$), except on Fridays, when tweets

from Muslims were especially positive ($b = 2.64$, $SE = .98$, $t(49,140) = 2.69$, $p < .001$). Contrary to what was predicted, Muslims were not more negative on Sundays, and Christians were not more positive on Sundays, but Christians were marginally more positive on Fridays ($b = 1.79$, $SE = .97$, $t(49,140) = 1.84$, $p = .07$).

For cross-study comparability and ease of interpretation, I compared atheists to affiliated users in a separate linear model. Since atheists have no holy day, the interaction between atheists and each day of the week was modeled (see Table 6).

This linear model a weekend effect, such that emotional tone in tweets was more positive on Saturdays ($b = 1.45$, $SE = .73$, $t(49,139) = 2$, $p < .001$) and Sundays ($b = 2.14$, $SE = .74$, $t(49,139) = 2.89$, $p < .001$). Atheism was not predictive of tone overall, but did predict more negative tone across some days of the week. Atheists were significantly less positive on Fridays ($b = -4.06$, $SE = 1.19$, $t(49,139) = -3.42$, $p < .001$) and Tuesdays ($b = -3.74$, $SE = 1.29$, $t(49,139) = -2.9$, $p < .001$), and marginally less positive on Saturdays ($b = -2.24$, $SE = 1.28$, $t(49,139) = -1.76$, $p = .08$) and Sundays ($b = -2.26$, $SE = 1.32$, $t(49,139) = -1.7$, $p = .09$). See Table 7 for statistics related to tone for religious affiliation by day of the week.

Tone in tweets from Egypt

The original plan for analysis included a comparison of tone in tweets written in English and tone of tweets in Arabic. Technical challenges prevented Arabic tweets from being reliably analyzed in LIWC (personal communication

Pennebaker, 2017), so tweets were only analyzed in English. The tweets from Egypt data set was created by subsetting tweets from the original 7 million set that were from the Cairo time zone and had been identified as belonging to a user with a specific religious affiliation. Of the 1,083 tweets that met these criteria, only 287 contained English words.

None of the users tweeting from Egypt followed any of the accounts used to identify religious affiliation. There were 64 self-identified Christians, 223 Muslims and zero atheists. Tweets were collected every day of the week, and most days were represented by over 40 tweets, but only 10 tweets were collected on Mondays. Due to this anomaly and the relatively small size of the Christian group from Egypt, I did not enter every day of the week as a factor in a linear model, as in the American analyses based on religious affiliation and state level religious attendance, and instead conducted an ANOVA that focused on holy days vs. other days, and how those days interacted with religious affiliation.

The mean emotional tone for tweets in the Egyptian sample was 39.25, with a standard deviation of 30.92. None of the factors in the ANOVA model (Sunday, Friday, religious affiliations and interactions) significantly predicted tone (see Table 8).

Religious majority-minority status across contexts

To assess the effects of religious majority/minority status on emotional tone in tweets, I analyzed the Egyptian tweets with the American tweets with new variables for country and the proportion of the country sharing a user's religious

affiliation. These were .71 for Christians, .01 for Muslims and .03 for atheists in the United States (Pew RLS, 2014) and .04 for Christians and .93 for Muslims in Egypt (Pew Global Futures, 2015).

In a linear model accounting for country, day of the week, proportion of users sharing religious affiliation within-country and all relevant interactions, only the share of others with the same religious affiliation significantly predicted tone in tweets ($b = 8.84$, $SE = 1.88$, $t(49,412) = 4.7$, $p < .001$; see Table 9).

Discussion

In study 1, tone in tweets was predicted by the degree of religious attendance in U.S. states and by religious affiliation across days of the week. Some hypotheses were confirmed and corroborated pilot studies, while others did not hold.

Subjective well-being in religious places

As in pilot study 2, individuals in more religious places expressed less positivity. Emotional tone in tweets was more negative in states with higher rates of attendance, and tweets from Egypt, a country with higher rates of religiosity (Pew, 2015) were less positive than those from the U.S., with mean tones of 39.25 and 42.05 respectively. Though it is probably true in general that Egypt is a more difficult place to live than the U.S., and that some states with high rates of religious attendance are more difficult to live in than some less religious states, these differences are minimized in this study due to the relative privilege of

Egyptians on Twitter, and by the analysis of state level religious attendance as a continuous predictor.

Religious affiliation and well-being

There were no differences in measured well-being between self-identified Christians and Muslims in Egypt, perhaps corroborating Diener et. al's (2011) conclusion that religious affiliation of any kind provides belongingness benefits that buffer contextual difficulties.

However, in the United States, Christianity positively predicted well-being, as measured by tone, while Muslim affiliation negatively predicted well-being. The tone of atheists was consistently around the average. In the U.S. context, it appears that any religious affiliation is not better than no affiliation. This is somewhat surprising given that Americans report being prejudiced against Muslims and atheists at comparable rates (Pew Research Center, 2017), but Muslim Americans are more often identifiable, and more likely to belong to two or more denigrated outgroups (i.e. recent immigrants) than atheists, whose lack of religious belief is invisible. Muslim Americans experience more prejudice and hardship, and this seems to be reflected in their well-being, even in this rough measure of tone in tweets. It seems telling that religious minority status was related to more negativity across contexts, in both the U.S. and Egypt.

Day of the week

More positivity was expressed during weekends in most models, but this effect was not very robust, sometimes disappearing or even reversing as variables

were added. This was consistent with pilot studies, in which day of the week per se did not predict positivity.

Christians did not become more positive on their holy day, but Fridays were the only days when Muslim Americans were more positive than average. This significant interaction might demonstrate the benefits of religious cues and attendance for religious minority members.

Limitations

Overall, the models estimated in study 1 had small effect sizes, leaving much of the variation in tone of tweets unexplained. Future studies could attempt to control for more variables. These studies may have failed to corroborate the interactions observed in the pilot studies for a few reasons. First, a different measure of emotional tone was used in study 1 than in pilot studies. Where pilot studies 1 and 2 represented subjective well-being as positive emotion in tweets, a LIWC analysis that generate a lot of zeros, study 1 operationalized well-being in terms of aggregated tone: positive, negative, or anywhere in between. Overall tone may be extracting less signal from noise than positive emotion words, though my assumption was (and is) that analyzing for tone more generally provides a more nuanced and robust measure of subjective well-being. Future studies could compare these methods, as well as tone measurements from other text analysis programs. It may be particularly useful to compare open source methods, since only some of the mechanics behind LIWC's proprietary tone analysis is available to the user. The pilot studies also included a smaller number of dates per day. This may have minimized some of the variance created by

seasons, events (though no major events occurred on any of the recorded dates), or randomness.

The Egyptian analysis could be improved with an analysis of tweets in Arabic, as planned. The Egyptian results are made less reliable by their small sample size of users tweeting in English. When LIWC or other programs have a reliable way to compare sentiment across languages, comparisons between languages will be illuminating. Until then, it might still be useful to collect and analyze more tweets from Egypt.

CHAPTER IV

STUDY 2 METHODS

The pilot studies and study 1 assumed that religious people and people in religious places were impacted by religious attendance patterns and cues on holy days. Study 2 measures attendance's impact on emotional tone in tweets more directly, by matching survey data on religious affiliation and attendance to participants' tweets.

Participants were 70 students recruited from a university human subjects pool at a large public university in the Pacific Northwest. Participants completed a questionnaire online that included items about their religious affiliation and attendance (as well as others, see materials in appendix for full details).

The item for assessing religious affiliation on the questionnaire stated, "Please select the option that best describes your religious affiliation." Possible responses were "Christian," "Hindu," "Jewish," "Pagan," "Muslim," "Buddhist," "Atheist," "Agnostic" and "Other." The Christian, Jewish and Muslim affiliation options included relevant subsects (e.g. Kharijite, Shia, Sunni and Other for Muslims), but were collapsed for analyses.

The attendance item asked, "How frequently do you attend religious services or community events," and response options were, "Never or less than once a year," "Once or twice a year," "A handful of times a year," "Once or twice a month," "Once or twice a week," "A handful of times a week," "Once a day," and "Multiple times a day."

The questionnaire also requested participants' Twitter handles. Up to 360 tweets per user, including retweets, were scraped using Twitter's public REST API, and the emotional tone of tweets was analyzed in LIWC, in the same procedure as in study 1. Tone of tweets was analyzed alongside information about participants' religious affiliation and attendance gleaned from the questionnaire.

CHAPTER V

STUDY 2 RESULTS

Of the 70 questionnaire participants, 53 provided a Twitter handle. Three of those 53 did not respond to items regarding religious affiliation and/or attendance. Forty three of the given Twitter handles led to valid accounts, 38 of which were open, public profiles. No attempt was made to follow private accounts using the study application's developer profile, so five participants were excluded on the basis of having protected tweets. The remaining 38 Twitter accounts were captured for analysis using the `twitter` package for R to interface with Twitter's public REST API. Users' 360 most recent tweets, including retweets and going back to the first day of 2016, were collected in an attempt to obtain an equal number of tweets between participants without going back to a time when their religious affiliation or attendance patterns were likely to be different than those reflected on the questionnaires (i.e. prior to the school year in which they were collected, when some participants might have been under 18, or in high school). The modal number of tweets per user was therefore 360, but the range was 1 – 360 with a mean number of tweets of 207.32 per user and a standard deviation of 151.24.

The average age of participants in this university human subjects pool sample was 19.82, with a standard deviation of 1.98. There were 22 females and 16 males. There were only five regular service attenders (i.e. participants who reported attending services or community events once per month or more often). Due to the small sample of regular attenders, religious attendance was analyzed

as continuous measure, rather than as a dichotomous variable (regular attenders compared to everyone else) as originally planned. There were 15 Christians.

There were 1,036 tweets from Sundays and 6,842 from all other days. A Bartlett test of homogeneity of variances was conducted to confirm that the data met the assumptions of linear regression despite the cell size differences between Sundays and non-Sundays ($\chi^2(1) = 1.37, p = .24$).

The mean tone was 41.29, with a standard deviation of 34.46 and a range of 1 – 99. A linear model predicting tone by Christianity, Sunday and frequency of religious attendance produced unexpected results (Table 10). Christianity ($b = -5.76, SE = 1.5, t(7,870) = -3.85, p < .001$) and religious attendance ($b = -1.66, SE = .47, t(7,870) = -3.573, p < .001$) were related to more negative tone in tweets, as was a three way interaction between Christianity, Sunday and religious attendance ($b = -3.1, SE = 1.57, t(7,870) = -1.98, p < .05$). However, an interaction between Christianity and attendance was related to more positive, happier tweets ($b = 2.54, SE = .59, t(7,870) = 4.34, p < .001$).

This model assumed that tweets were independent observations, but graphing tone of tweets across days by the interaction of Christian affiliation by attendance rate, representing each user as a different color, demonstrates the problematic nature of this approach. Within-user consistency in tone is apparent (figure 1).

A linear mixed-effects model utilizing a restricted maximum likelihood approach (using the lme4 package for R) revealed that, after accounting for

within-user stability in emotional expression in tweets, all other effects were diminished and rendered statistically insignificant (Table 11).

Discussion

Though there were thousands of observations analyzed for tone, there were only 38 individual users available to analyze in study 2, and only 15 of those were Christians. Within user stability in tone is interesting in and of itself, but it prevented meaningful analysis of tweets as independent observations, so analysis was impeded by these small sample sizes. In future studies, accounting for the propensity of participants to submit incomplete questionnaires and to provide Twitter handles that are invalid or private when determining appropriate sample sizes could enable a more powerful analysis.

Obtaining a large sample of Christians, with a range of religious attendance patterns, is challenging among young adult college students, due to generational and developmental patterns in affiliation and attendance. Young adults across generations have the lowest rates of religiosity (Pew Research Center, 2014), and the young people of today are even less religious than previous generations were within the same developmental time period. Further, the Pacific Northwest is a relatively irreligious place, based on national samples. This is apparent within these survey data. Twenty four of the original 70 participants identified as either atheist or agnostic, compared to only 7% of the general population of American adults.

CHAPTER VI

STUDY 3 METHODS

As a more conventional and face valid approach to measuring subjective well-being across religions and contexts, global survey data were analyzed. Data come from Pew Research Center's Global Attitudes team's Spring 2015 survey of 45,435 adults in 40 countries. Surveys were conducted by phone or face-to-face, depending on country. Random stratified sampling was used, usually resulting in nationally representative samples. In some cases, nationally representative samples were not possible or practical because an area was unsafe or too difficult to reach. For example, face-to-face interviews could not be conducted in all areas of Nigeria due to unrest and security concerns, and some communities within Palestinian territories could not be reached because of military restrictions. Princeton Survey Research Associates International conducted interviews in each country's native language(s). Surveys were completed between March 25 and May 27 of 2015.

Across countries, interviews began with the same simple warm-up question: "How is your day going so far?" Response options to this question were better than a typical day, worse than a typical day, or about a typical day. Religious affiliation of survey respondents was also collected, with categories varying across countries. The proportion of others sharing religious affiliations within-country was gathered from Pew's (2015) Global Religious Futures project estimates. Country, religious affiliation, share of the country with respondents'

affiliation and day of the week were used to predict responses to “How is your day going so far?”

CHAPTER VII

STUDY 3 RESULTS

Overall means by religious affiliation and day of the week show a holy day effect on reported well-being for Christians, Muslims and Jews (fig. 2). Since the outcome measure of this study – the answer to “how is your day going today,” was on a three point scale, ordinal logistic regression was used to assess the contributions of religious affiliation, day of the week, and the percentage of the country’s population sharing the affiliation of an individual. Overall results are presented in table 12. Buddhism, Judaism and lack of religious affiliation are related to reporting worse days, while Christian, Hindu and Muslim affiliations relate to better days, overall. Proportion of those with the same religious affiliation within country was associated with reports of worse days, overall, perhaps reflecting a small negative difference in countries with high degrees of religious homogeneity.

There was a great deal of variability between countries. Interestingly, reports of how respondents’ days were going appear unrelated to relative comfort or prosperity of countries (see map, figure 3). For example, subjective well-being is reportedly higher in Pakistan than in any European country (Table 13).

As a test that is more analogous to those presented in the other studies, I compared Sundays, Fridays, Christians, Muslims, and their interactions. There were 21,337 Christians and 9,893 Muslims; 5,448 surveys were conducted on

Sundays and 5,744 were conducted on Fridays. How these variables related to subjective well-being was estimated in another ordinal logistic regression (Table 14). I hypothesized that affiliation, religious majority status (the percentage of others sharing religious affiliation within-country, labeled “similarity” in Table 14), holy day and all interactions between these variables would predict increased well-being.

Christian and Muslim religious affiliation were both related to higher reported well-being. Sundays were more positive than other days. The percentage of people sharing an individuals’ religious affiliation (“similarity” in Table 14) predicted slightly lower well-being overall, but slightly higher well-being for Christians and slightly lower well-being for Muslims. Christians in countries with greater proportions of Christians were less happy on Fridays, and no other three-way interactions were significantly related to well-being.

Discussion

Cross-nationally, Christians, Jews and Muslims demonstrated a holy day effect on self-reported well-being, each reporting their best average day on their respective holy days. Since weekends vary by country, but typically include the holy day of the largest religious group, it is unclear to what degree the weekend effect observed in Gallup’s (2011) polls of Americans explains the positivity of holy days globally. Country averages and an ordinal logistic regression appear to indicate that relative prosperity within country is unrelated to well-being in reports of how respondents’ days are going so far, but I did not include a measure

of country level prosperity. Percentage of others sharing one's religious affiliation within country consistently predicted slightly lower well-being, which was wholly unexpected, and may indicate that the effect of this country-level variable is obscured by others. Including more country-level variables might clarify the relationship between prosperity within country and well-being. Similarly, results of the regression comparing Christian and Muslim affiliates by holy days and religious majority status were mostly unexpected, and the unexpected directional influence of the similarity variable seems to drive the results that did not align with hypotheses.

CHAPTER VIII

STUDY 4 METHODS

Finally, as a purely exploratory step, tweets collected for study 1 were analyzed for content. Tweets classified for U.S. state and tweets from Americans who were classified as members of a religious group were analyzed using structural topic modeling (with the `stm` package for R). The two data sets were analyzed separately. Topic modeling in general allows for the description of the topical contents within large bodies of text, and structural topic modeling takes this a step further by allowing researchers to model document-level covariates of theoretical interest and obtain results indicating their relations to latent topics based on a general linear model framework (Roberts, Stewart, Tingley & Airoidi, 2013). For both levels of analysis, I iteratively ran 4 of each model consisting of 20, 40 and 50 topics. In both cases, models with 50 topics fit the data best. I selected one of the models from the four available based on visualizations of semantic coherence and frequency.

Content of tweets by state

A portion of the dataframe with user accounts classified by state in study 1 was analyzed for latent topics using structural topic modeling, to account for day of the week and state-level church attendance as covariates predicting topics. Structural topic modeling approaches work best with at least one binary covariate (Roberts, Stewart & Tingley (2017), so I compared the 10 states with the highest

rates of religious attendance to the 10 states (or, more precisely, 9 states plus the District of Columbia) with the lowest rates of religious attendance.

Tweets were preprocessed to remove numbers, symbols, punctuation, stop words, and words used in fewer than 250 tweets (out of the set of 292,146 with high/low religious attendance). Text in tweets were also lowercased and stemmed. A latent Dirichlet allocation initialization was used to construct 20 models, each of which extracted 50 topics from the corpus of tweets, going through a maximum of 100 iterations to reach convergence. The final model was selected based on a balance between semantic coherence within topics, semantic exclusivity between topics, and ease of interpretation. Once an overall model was selected, the structural modeling approach allowed the extraction of point and effect estimates to assess the relation of topics to high vs. low state-level religious participation, day of the week, and topics.

Contents of tweets by religious affiliation

A nearly identical procedure was used to analyze the contents embedded within tweets from the dataset of users identified as belonging to a particular group in study 1. To create a dichotomous covariate for ease of analysis, and to create a model for qualitative analysis that involved the central contrast for this dissertation, atheists were excluded and the religious comparison was between Christian and Muslim users. Day of the week was also analyzed as a covariate. The same preprocessing steps, analysis, and model selection steps were taken as in the analysis of latent topics by state.

CHAPTER IX

STUDY 4 RESULTS

Topical content in tweets varied based on religious affiliation, religious geography and day of the week.

Content of tweets by religious affiliation

The best quality structural topic model identifying latent topics and their relationships to religious affiliation, day of the week and those variables' interactions contained the 50 topics summarized in figure 6. I chose to further explore topics 41, 49, 30, 35, 18, 36, and labeled them Support Conservatives, Never Trump, Islamophobia, Christianity, Faith and Prayer respectively, based on their associated word stems (Table 15). Based on difference scores, Christians and Muslims were equally likely to discuss Prayer in tweets (Figure 6). Christians were more likely to discuss Christianity, Faith, Support for Conservative political candidates and to voice views related to Never Trump. Muslims were more likely to discuss Islamophobia, sometimes while retweeting from Infowars and referring to Alex Jones (see Table 15 and Figure 5 [days of the week differences with Table 16]).

Content of tweets by state-level affiliation

The best quality structural topic model at detecting latent topics within tweets and their associations with day of the week and high versus low attendance states is summarized in figure 7. I chose only a few of the topics

identified by the model for further analysis: topics 24, 41, 20 and 45. Based on the associated word stems (Table 17), I labeled these topics Politics, Positivity, Negativity and The Present, respectively. Based on difference scores (Figure 8), the politics topic was more commonly discussed in the low attendance states, while the high attendance states discussed Negativity more frequently. Other associations by dichotomized state attendance rate and day of the week interactions are in Table 18.

Discussion

Both topic models contained a great deal of political content. There were many differences in prevalence of topics across days of the week. Many, particularly the religiously relevant topics, have patterns that are based on weekend and holy days, but others do not have obvious explanations. More exploration of these differences is needed, but it may be that there were events on one or more of the representative days of the week on which data were collected that explain these differences. For example, there might be one or more events that drive the increased prevalence of support for conservatives on Tuesdays and Wednesdays relative to other days. Difference scores indicated that Muslims were more likely to discuss Islamophobia than were Christians, while Christians were more likely to discuss all other topics besides prayer, which was equal across affiliation groups. Future studies could examine other account-level variables that might explain which Christians expressed support for conservatives, and which tweeted content related to “never Trump,” since both of these topics were more commonly expressed by Christians than Muslims. Attendance patterns by state and day of the week followed relatively understandable patterns, and the appearance of topics related to positive and negative emotional expression was a convenient development. In this second model again though, pulling from a larger number of days, or having a way to include news events of the dates collected, might explain some of the topical change over days of the week. Future

topic models studying the effect of days of the week on content should include many more dates than the two to five per each day in this collected data set.

CHAPTER X

GENERAL DISCUSSION

Despite a recent uptick in theoretical and experimental work in the psychology of religion, this topic is relatively underexplored, particularly given its proportional weight in the lives of most individuals (Rozin, 2009). Though the paradoxical relationship between religious belief, religious geography and well-being has been described fairly extensively, little work has been done to disentangle potentially relevant variables such as majority/minority religious group status, measures of well-being or temporal factors. The goal of this dissertation was to contribute to those aims.

Well-being and religious affiliation

In study 1, American Christians had greater well-being, as measured by tone in tweets, than Muslims, who were especially negative. Atheism did not predict tone in tweets. The negativity related to Muslim affiliation in the U.S. was further illustrated in content analysis. In the American context, religious affiliation alone is not sufficient to boosting well-being. Muslim Americans, who face a great deal of difficulty and discrimination, may actually fare worse due to their affiliation, though the degree to which their differentially low well-being is mediated by religious affiliation per se, compared to other minority factors and stresses that tend to correspond with Muslim American identity, is unclear.

In study 2, Christian affiliation predicted more negativity in tweets overall. The effect was diminished when tweets were nested within users, but did not

reverse. Christian college students in the Pacific Northwest, in a geographic region and developmental life stage when religiosity is less common, did not have measurably higher well-being. The impact of interactions between developmental and geographic religious demographics may be a fruitful line of future research, since social support comes from peers, rather than institutions.

Responses to the question, “How is your day going so far?” around the world, analyzed in study 3, varied based on religious affiliation. Religious believers were not universally better off, even in difficult conditions, as one would expect based on Diener et al.’s (2011) and others’ supposition that religious belief buffers against difficult life circumstances by providing support and meaning. Buddhist and Jewish religious affiliations actually predicted more negative reports of well-being globally, when accounting for day of the week and religious majority/minority status, and the religiously unaffiliated were not more negative than others. Christians, Hindus and Muslims did tend to report greater well-being.

Well-being and religious geography

Twitter users in religious places demonstrated lower well-being. Tone was negatively correlated with religious attendance at the state level in study 1. This finding replicated pilot study 2 using a continuous measure of aggregate religious attendance, rather than a comparison between the few highest attending states and the few lowest attending states, and provided a stronger test for the influence of religious geography over other contextual factors. Tweets from Egypt, a more

religious country than the U.S., were more negative than those of Americans in studies 1 and 2.

Globally, Christian religious affiliation interacted with Christian majority status to predict greater well-being, but Muslims in Muslim-majority contexts were slightly less happy. Though I did not conduct any statistical analyses correlating religiosity or reported well-being with nation-level misery factors, it did stand out that well-being was higher in Pakistan and most countries in sub-Saharan Africa than in most European countries. Future studies could incorporate country and person-level factors related to suffering to explore this further.

Holy day effects on well-being

In my analyses of day of the week as a factor with seven levels, as opposed to the pilot comparisons between holy day and not, there was limited evidence for the efficacy of holy day primes or religious attendance to temporarily boost well-being. In study 1, Americans were generally more positive on Sundays, but state-level religious attendance did not interact with Sunday, and Christians were not especially positive on Sundays. American Muslims, however, were most positive on Fridays. This finding might highlight the importance of increasing access to coreligionists and ritual communion among religious minorities.

Christian American college students in a context where they represent a minority trended toward displaying lower well-being overall, but higher well-being on Sundays. These relationships were both just outside the range of being

marginally significant statistically, so it would be unwise to draw inferences from them, but the small sample size of only 15 Christian students and the way that these relationships paralleled those of Muslim Americans make them intriguing. Future studies could assess well-being among other religious minorities, and in other contexts where Christianity is more rare or less valued than in the U.S. in general.

In global survey data, Christians, Muslims and Jews all reported greatest well-being on their respective holy days. I hypothesized that outgroup holy days would function as reminders of lower social status and discrimination for minority religious group members, and therefore depress well-being, but I found no evidence to support this hypothesis in any of the analyses.

Comparing self-reports and naturalistic results

Since I was unable to compare accounts coded for religious group based on self-reports and accounts coded based on accounts followed, it must be acknowledged that the Twitter data analyzed by affiliation may be influenced by self-enhancement biases that make traditional self-reports problematic. It is possible that Twitter users who self-identify as Christian or Muslim in their profiles feel compelled to represent their groups by tweeting more positively than users with similar levels of belief who may not self-identify, but do follow discriminative accounts. Despite this potential limitation, these studies provide compelling results and potential future avenues, especially when contrasted side-by-side and with previous research.

Religious affiliation generally predicted self-reports of well-being in global surveys, with religious “nones” being less positive than most others, despite the number of countries polled in which religiosity is not nearly universal or particularly valued. More work is needed to disentangle country-level variation, as indicated above. Also somewhat contradicting Diener et al.’s (2011) supposition, affiliation alone was not sufficient to improve well-being based on the emotional valence of tweets. Some religious affiliations were beneficial, and some were not. This depended on majority status, to an extent. Muslim affiliation was worse than none at all in the United States, based on tweets.

Since country determines well-being and religions’ relations to well-being to such a large extent, comparing results of methods within country may be most useful, and American Christians’ well-being benefit is apparent both in tweets and in self-reports. This alleviates some concern about positive well-being bias in self-reports, and argues for the utility of Twitter sentiment analysis in measuring well-being by religion, since it maps onto what we know based on traditional methods and mortality rates.

Other Future Directions

The present investigation had a number of limitations that could be minimized in future studies, and more research is needed to further delineate the differential influences of religious identity and attendance, compared to religious geography, on well-being. Future research could also focus on demographic differences beyond the religious – on developmental differences in religiosity’s relation to well-being, for example.

In the present investigation, analyses were based on either religious geography, or personal religious identification, and nesting people within places may be more illuminating. State-level analyses were also the most fine-grained in terms of religious geography, but in some cases county or postal code specific religious demographics are available. Country, state or more detailed geographic analyses could also account for factors related to suffering, controlling for income and health differences directly.

Based on the results obtained, I expect that controlling for place-level covariates, like income inequality and conflict, would demonstrate a consistent religious majority well-being boost in both tweets and self-reports. Muslim majority countries and Christian majority countries are importantly different from one another, and this appears to have obscured religious differences in both self-reports and tweets. To do robust within-country comparisons, larger sample sizes would often be needed compared to the surveys in study 3, or Egyptian tweets in study 1. With only 1,000 respondents per country, small religious minorities cannot be compared to others. This limitation may be practically insurmountable in a single survey. However, aggregating surveys across years and research organizations could provide the power for these comparisons in future studies. This would be particularly useful in places with low rates of Twitter penetration, or in countries where English is uncommon and therefore difficult or impossible to analyze for sentiment using current tools. At this point surveys are more useful for global research.

There were differences between the results of in-person and phone interviews compared to sentiment on Twitter in Egypt that may indicate religious self-enhancement. However, the present investigation confounds mode and measure entirely. Future research could explore how religious believers and non-believers alter their Twitter feeds when they know they are being studied. This could be done by comparing users who consent to having all of their tweets analyzed for the next few months compared to those who are analyzed without the users' knowledge, and users who self-identify in their descriptions to those who follow discriminative accounts.

In general, the expansion of Twitter sampling methods to include users who do not self-identify is still a worthy step. Since matching user accounts from the streaming API to accounts that discriminate users based on religious affiliations failed in study 1, future studies could collect the tweets of a random sample of users who follow the 45 identifying accounts. The method for identifying user affiliation by those accounts seems sound, but the identification could not be executed using the method in study 1. If user tweets are collected *after* the accounts have been identified by affiliation, comparisons between people who self-identify and those who are more subtle about their religion on Twitter can be compared.

Topic modeling indicated that Twitter users in the U.S. experience and react to many of the same things. This makes sense, due to media structures and the way information is gathered, particularly by Twitter users, but these commonalities made parsing differences between users based on their differences

more difficult. Future topic models could extract a greater number of topics, use different methods of initialization, include a larger number of dates per day of the week, or exclude subjects that are so common as to create additional noise, as in some of the political content extracted in many topics.

There are many more analyses that can be done using only the data from study 1 and additional LIWC analyses. For example, one could analyze for how much religious content is communicated via Twitter across days of the week, and how that interacts with tone. The prevalence of self references, curse words and words related to status or family are all easily analyzed.

Conclusion

These studies consistently demonstrated that religious affiliation is not necessary or sufficient for improved well-being across contexts, but that majority group religious affiliation sometimes enhances well-being, while minority religious group status tends to depress it. Day of the week effects on language and well-being were observed, but interactions between affiliation and holy day may only be important in as much as they allow religious minorities access to coreligionists that they do not have on other days. While these studies provided some insights, the contradictory relationships among religious people, religious places and well-being are largely unexplained and could benefit from additional study, particularly into the contributions of majority status and societal level suffering.

APPENDIX A

FIGURES

Figure 1. Average Tone by Day of the Week



Figure 2. Religious Affiliation by Day of the Week on Well-Being

How is your day going so far?

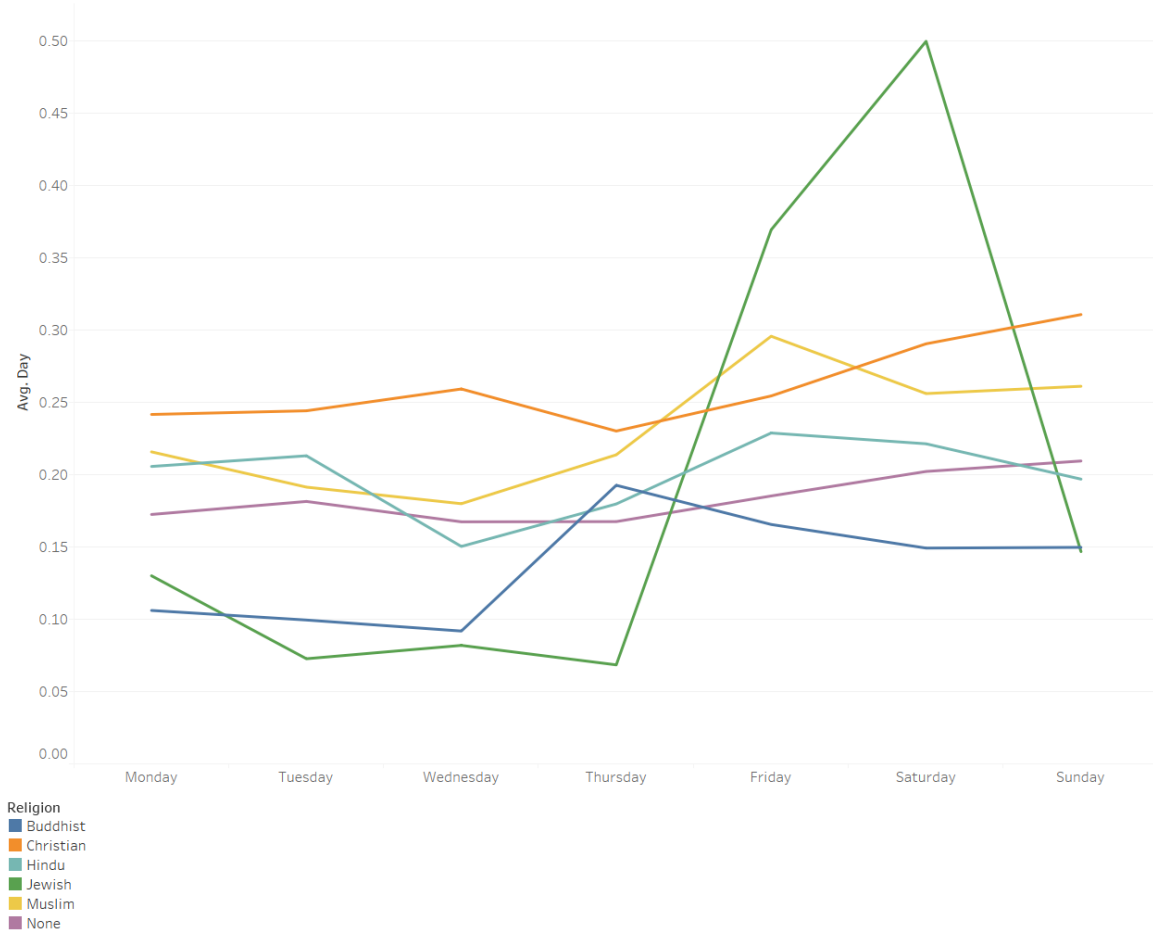


Figure 3. Country-Wide Measures of Subjective Well-Being

How's your day going so far?

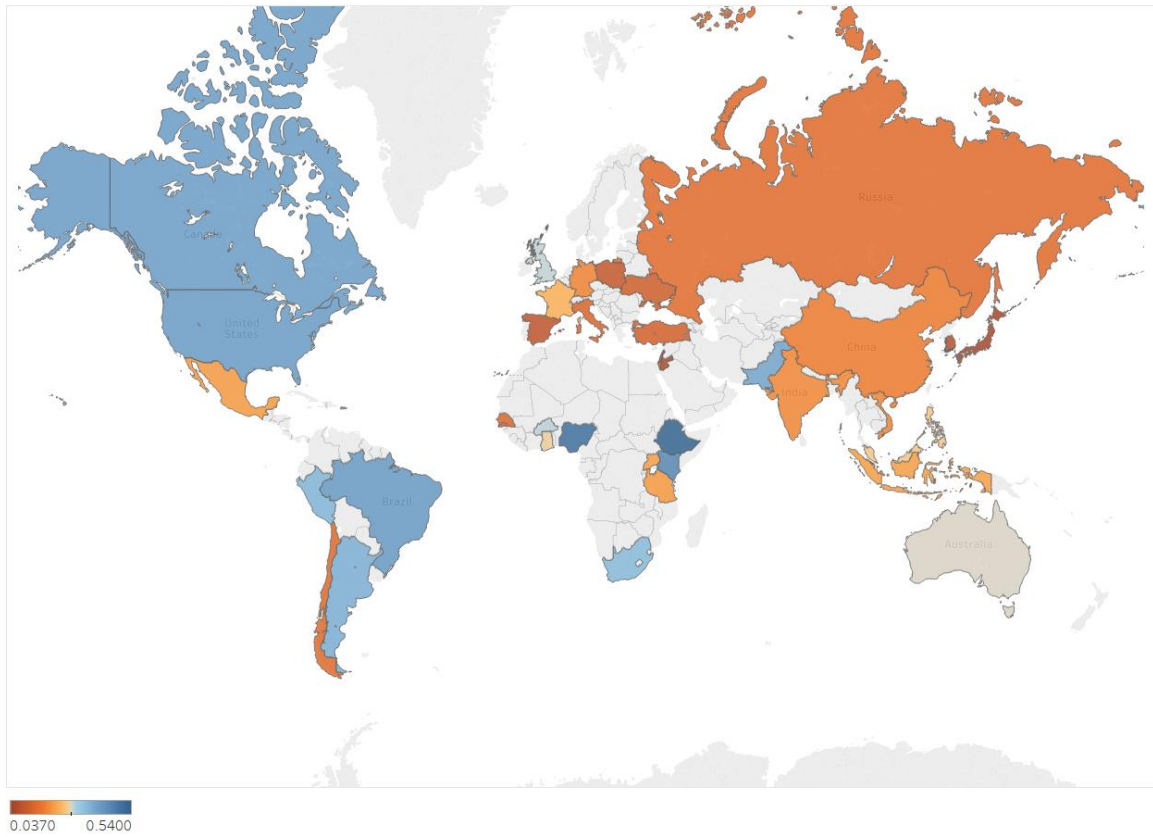


Figure 4. Country-Wide Well-Being by Religion

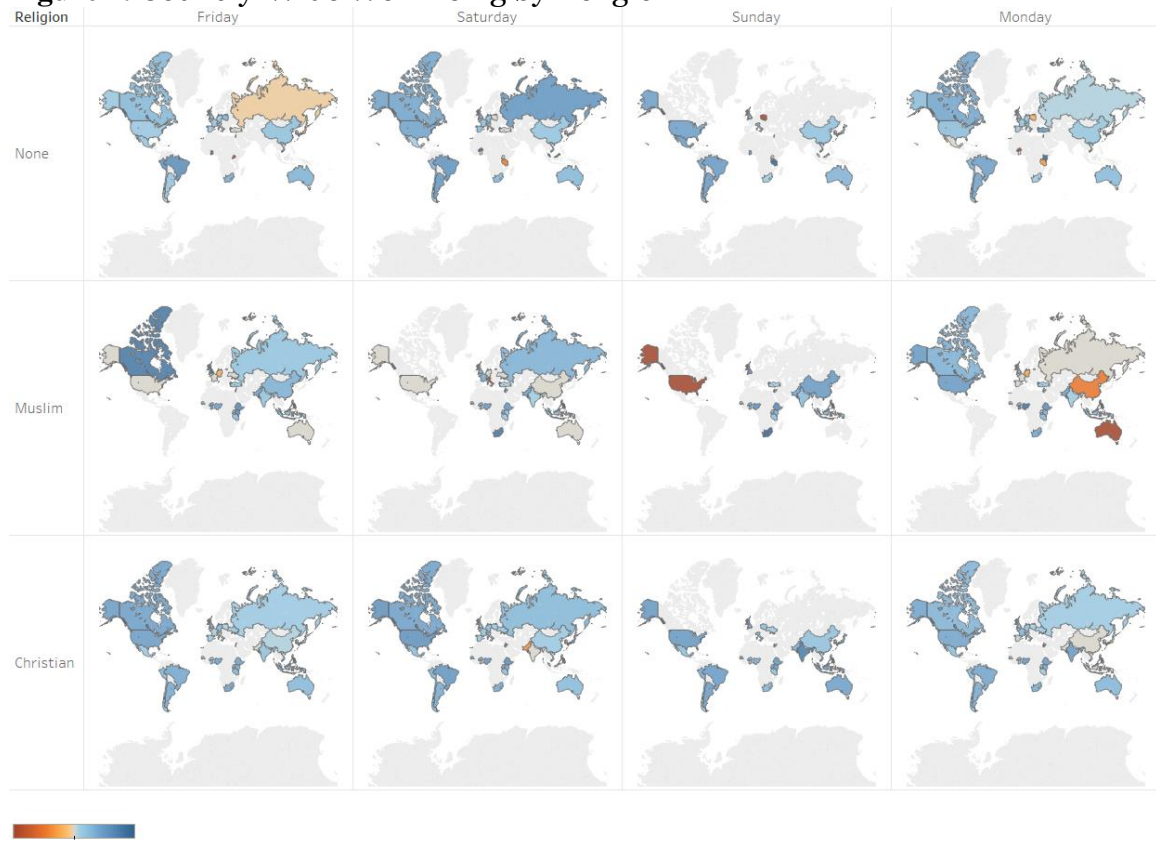


Figure 5. Overall Topics by Religious Affiliation and Day of Week

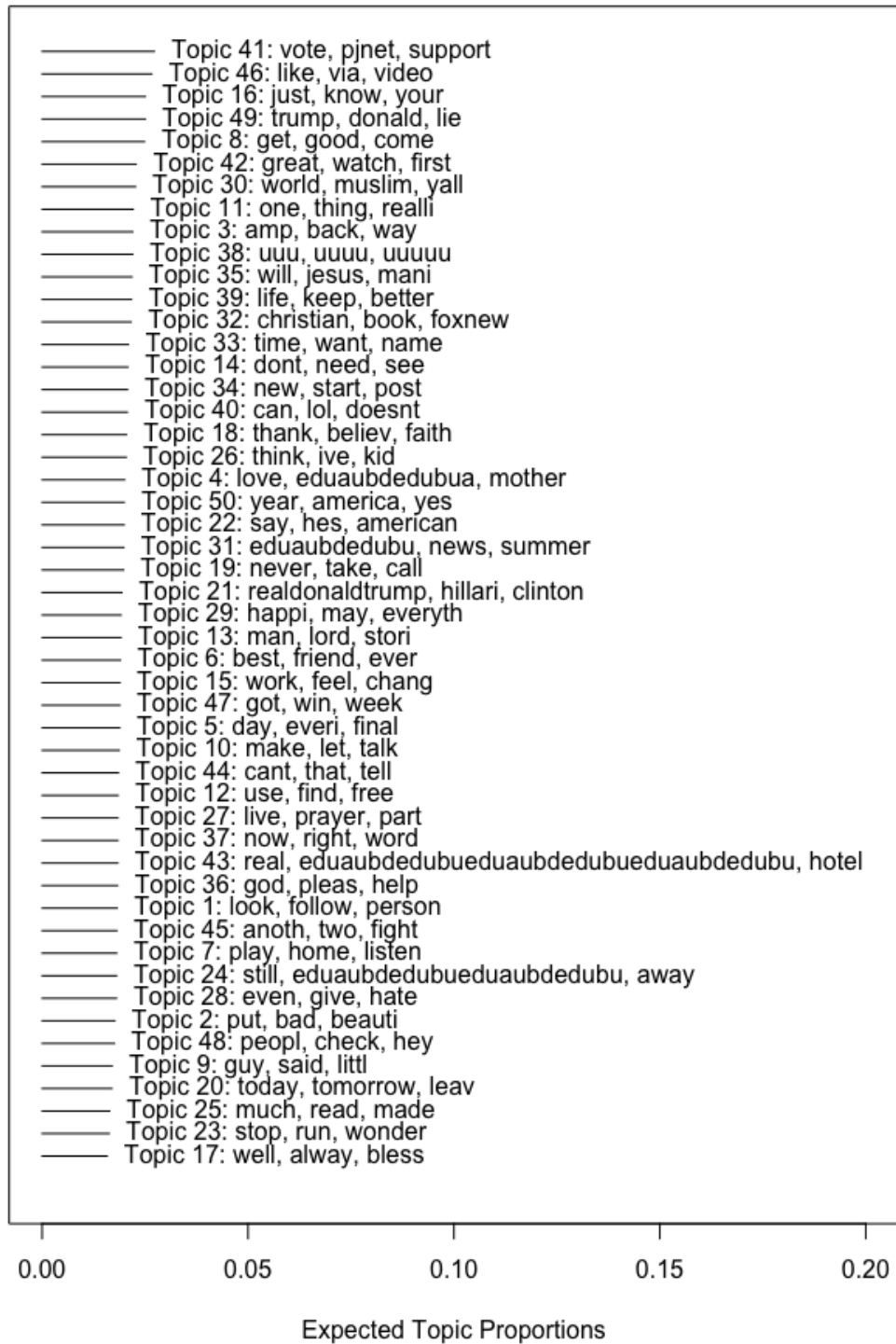


Figure 6. Differences in Topics by Religious Affiliation

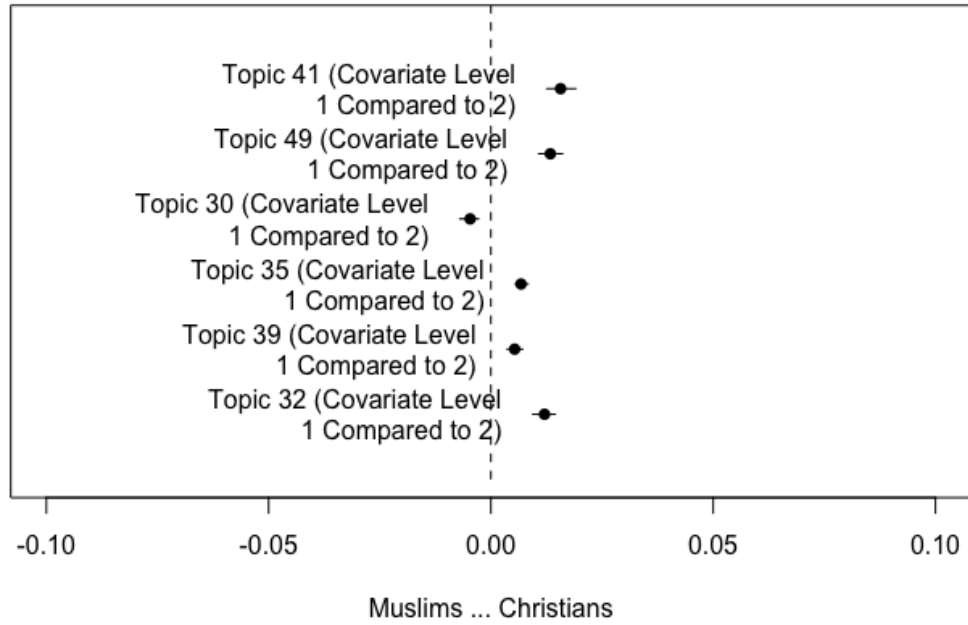


Figure 7. Topics by State

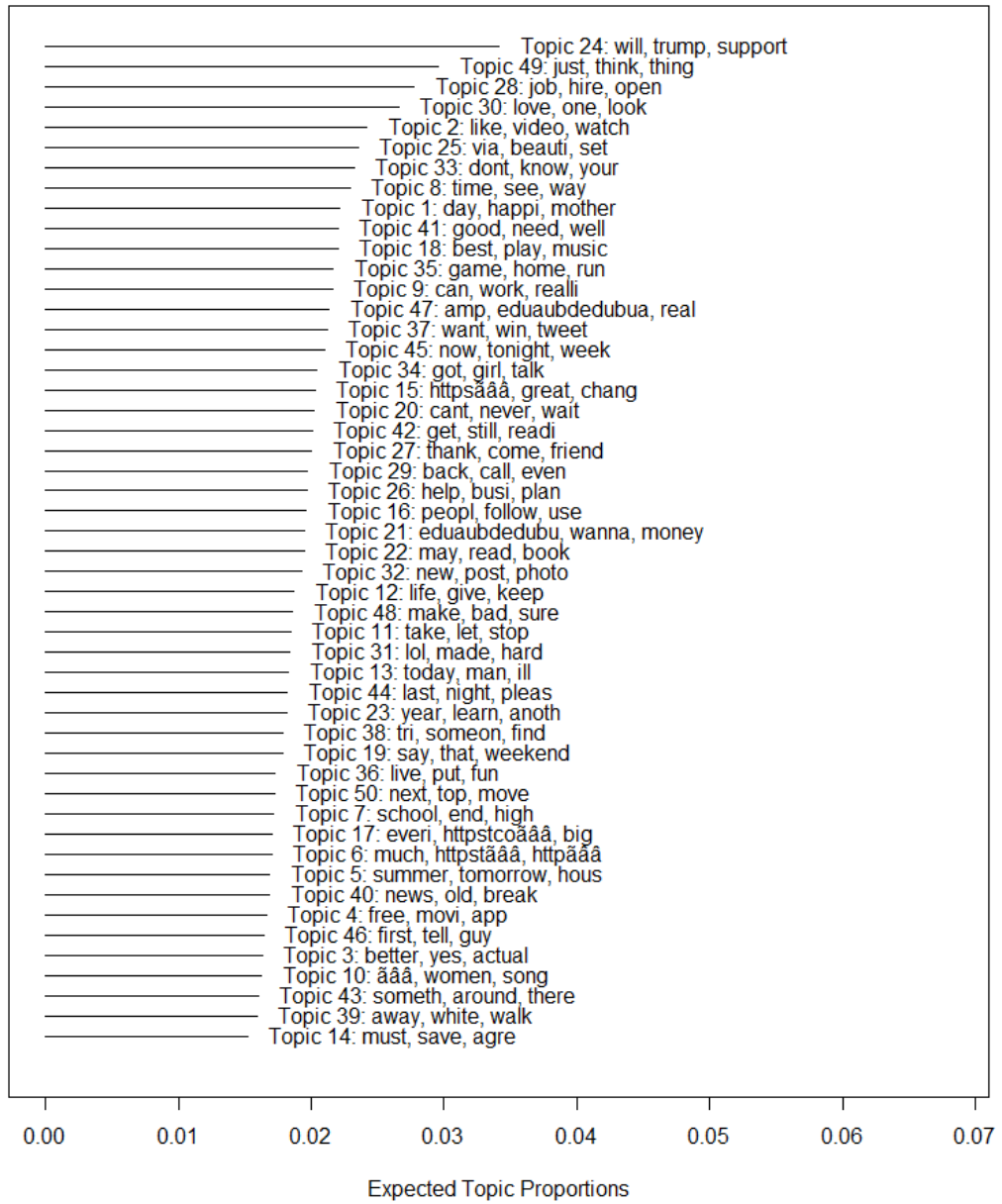
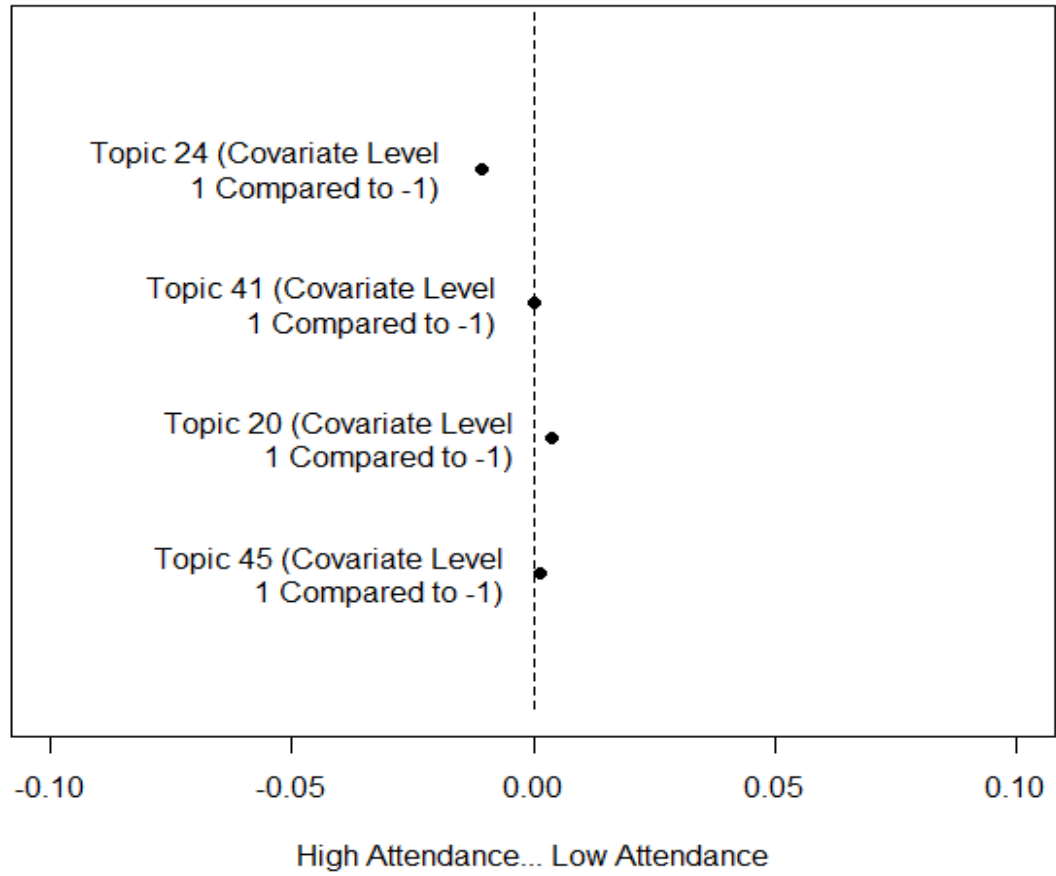


Figure 8. Differences in Topics by State Attendance Level



APPENDIX B

TABLES

Table 1. Discriminative Twitter Accounts for Religious Affiliation

Christian	Muslim	Atheist
TimTebow	ImamZaidShakir	AtheistQOTD
JohnCMaxwell	Muftimenk	Hemantmehta
JoyceMeyer	ImamSuhaibWebb	Rickygervais
MattChandler74	TariqRamadan	TheScienceGuy
louiegioglio	Hadithoftheday	AmericanAtheist
lecrac	boonaamohammed	Neiltyson
christomlin	Muslimvoices	Pzmyers
JohnPiper	MuslimMatters	RichardDawkins
CSLewisDaily	Icna	Billmaher
RickWarren	TheNobleQuran	SamHarrisOrg
Karijobe	IslamicThinking	Pennjillette
BethMooreLPM	AbdulNasirJ	ThinkAtheist
AndyStanley	AJEnglish	MrAtheistPants
PastorMark	YasirQadhi	AtheistQ
MaxLucado	hamzayausuf	TheTweetOfGod

Table 2. Descriptive statistics for tone by in states analysis

	<i>M</i>	<i>SD</i>
Sunday	45.07	35.92
Monday	42.91	35.17
Tuesday	43.19	35.26
Wednesday	43.94	35.63
Thursday	43.29	35.44
Friday	43.82	35.5
Saturday	44.14	35.5

Table 3. Influence of State Level Church Attendance and Day of the Week on Tone (Reference is Thursday)

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Intercept	41.91	0.2	212.96	< .001
State Rank	0.04	0.01	5.64	< .001
Friday	0.96	0.28	3.42	< .001
Saturday	1.41	0.28	5.06	< .001
Sunday	2.03	0.28	7.24	< .001
Monday	-0.08	0.28	-0.28	0.78
Tuesday	0.84	0.28	3.00	< .001
Wednesday	0.65	0.28	2.35	< .001
State x Friday	-0.005	0.01	-0.5	0.62
State x Saturday	-0.02	0.01	-2.51	< .001
State x Sunday	-0.01	0.01	-1.06	0.29
State x Monday	0.01	0.01	0.69	0.49
State x Tuesday	-0.02	0.01	-1.89	0.06
State x Wednesday	0.004	0.01	0.46	0.64

Note: $R^2 < .001$, $F(13, 1048560) = 33.02$, $p < .001$

Table 4. Descriptive statistics for tone of tweets in affiliation analysis

	<i>M</i>	<i>SD</i>
Sunday	45.76	36.22
Monday	43.65	36
Tuesday	45.04	36.03
Wednesday	44.33	36.04
Thursday	44.02	35.86
Friday	44.42	35.92
Saturday	45.01	36.12

Table 5. Influence of Religious Affiliation and Day of the Week on Tone
(Reference is Thursday)

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Intercept	40.42	0.52	77.96	< .001
Christian	4.65	0.47	9.81	< .001
Muslim	-1.33	0.49	-2.74	< .01
Friday	-1.58	0.79	-1.98	<.05
Saturday	0.81	0.60	1.36	0.17
Sunday	1.16	0.93	1.24	0.22
Monday	0.14	0.88	0.16	0.87
Tuesday	0.14	0.60	0.23	0.82
Wednesday	0.49	0.57	0.85	0.39
Christian x Sunday	0.53	1.19	0.45	0.65
Muslim x Friday	2.64	0.98	2.69	<.01
Christian x Friday	1.79	0.97	1.84	0.07
Muslim x Sunday	0.95	1.17	0.82	0.41

Note: R2=<.01, F(12, 49140)=23.88 , p<.001)

Table 6. Influence of Atheism and Day of the Week on Tone
(Reference is Thursday)

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Intercept	41.67	0.53	79.03	< .001
Atheist	0.08	0.93	0.09	0.93
Friday	1.12	0.68	1.64	0.10
Saturday	1.45	0.73	2.00	<.05
Sunday	2.14	0.74	2.89	<.005
Monday	0.88	1.07	0.82	0.41
Tuesday	1.30	0.73	1.80	0.07
Wednesday	0.96	0.70	1.38	0.17
Atheism x Friday	-4.06	1.19	-3.42	<.001
Atheism x Saturday	-2.24	1.28	-1.76	0.08
Atheism x Sunday	-2.26	1.32	-1.71	0.09
Atheism x Monday	-2.13	1.90	-1.12	0.26
Atheism x Tuesday	-3.74	1.29	-2.90	<.005
Atheism x Wednesday	-1.54	1.22	-1.26	0.21

Note: R2=<.01, F(13, 49139)=5.65 , p<.001)

Table 7. Mean Tone and Standard Deviations for Religious Affiliation by Day of the Week

	Mean	SD
Christian Sunday	46.76	36.72
Christian Monday	44.52	36.51
Christian Tuesday	45.91	36.46
Christian Wednesday	45.07	36.55
Christian Thursday	45.05	36.38
Christian Friday	45.29	36.42
Christian Saturday	45.98	36.69
Muslim Sunday	41.20	33.68
Muslim Monday	40.19	33.93
Muslim Tuesday	39.61	33.30
Muslim Wednesday	39.79	32.64
Muslim Thursday	37.90	32.63
Muslim Friday	40.19	33.37
Muslim Saturday	40.11	32.55
Atheist Sunday	41.58	36.79
Atheist Monday	40.44	36.02
Atheist Tuesday	39.35	35.36
Atheist Wednesday	41.22	36.34
Atheist Thursday	41.61	37.29
Atheist Friday	38.81	34.12
Atheist Saturday	40.90	35.67

Table 8. Analysis of Variance of Tone for Religious Affiliation and Day of the Week

	Sum of Squares	df	Mean Square	F	p
Religious Affiliation	489.00	1	488.60	0.51	0.75
Sunday	99.00	1	98.80	0.10	0.48
Friday	1911.00	1	1910.50	1.98	0.16
Religious Affiliation x Sunday	10.00	1	10.30	0.01	0.92
Religious Affiliation x Friday	168.00	1	168.40	0.18	0.68
Error	270828.00	281	963.80		

Table 9. Influence of Country, Religious Majority/Minority Status, and Day of the Week on Tone (Reference is Thursday)

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Intercept	38.83	1.25	31.17	<.001
Egypt	5.86	10.18	0.58	0.57
Status	8.84	1.88	4.70	<.001
Friday	0.66	1.59	0.42	0.68
Saturday	1.28	1.70	0.76	0.45
Sunday	2.29	1.72	1.33	0.18
Monday	1.69	2.55	0.66	0.51
Tuesday	0.49	1.72	0.29	0.78
Wednesday	1.29	1.63	0.79	0.43
Egypt x Status	-20.53	12.94	-1.59	0.11
Egypt x Friday	-12.76	15.72	-0.81	0.41
Egypt x Saturday	-10.02	17.59	-0.57	0.57
Egypt x Sunday	-4.86	16.25	-0.30	0.77
Egypt x Monday	-21.08	24.19	-0.87	0.38
Egypt x Tuesday	10.48	15.75	0.67	0.51
Egypt x Wednesday	-4.13	15.32	-0.27	0.79
Status x Friday	-0.64	2.40	-0.27	0.79
Status x Saturday	-0.53	2.58	-0.21	0.84
Status x Sunday	-0.85	2.62	-0.33	0.75
Status x Monday	-3.26	3.84	-0.85	0.4
Status x Tuesday	0.48	2.60	0.18	0.85
Status x Wednesday	-1.84	2.47	-0.74	0.46
Egypt x Status x Friday	13.48	19.37	0.70	0.49
Egypt x Status x Saturday	19.00	21.80	0.87	0.38
Egypt x Status x Sunday	10.51	19.97	0.53	0.6
Egypt x Status x Monday	26.70	31.07	0.86	0.84
Egypt x Status x Tuesday	-4.01	19.68	-0.20	0.84
Egypt x Status x Wednesday	13.31	18.87	0.71	0.48

Note: $R^2 = <.005$, $F(27, 49412) = 6.15$, $p < .001$

Table 10. Influence of Christian Affiliation, Church Attendance, and Sunday on Tone

	b	SE	t	p
Intercept	44.20	0.98	45.30	<.001
Christian	-5.76	1.50	-3.85	<.001
Attendance	-1.66	0.47	-3.57	<.001
Sunday	1.72	2.82	0.61	0.54
Christian x Attendance	2.55	0.59	4.34	<.001
Christian x Sunday	7.09	4.38	1.62	0.11
Attendance x Sunday	0.30	1.21	0.24	0.81
Christian x Attendance x Sunday	-3.10	1.57	-1.98	0.05

Note: $R^2 = <.005$, $F(7, 7870) = 3.88$, $p <.001$)

Table 11. Influence of Christian Affiliation, Church Attendance, and Sunday on Tone (REML)

	b	SE	t	p
Intercept	43.88	2.48	17.70	<.001
Christian	-6.18	3.81	-1.62	0.11
Attendance	-1.32	1.25	-1.05	0.30
Sunday	1.69	2.80	0.60	0.55
Christian x Attendance	2.34	1.60	1.46	0.15
Christian x Sunday	6.75	4.35	1.55	0.12
Attendance x Sunday	-0.31	1.22	-0.26	0.80
Christian x Attendance x Sunday	-2.33	1.57	-1.49	0.14

Table 12. Influence of Religious Affiliation on Well-Being

	b	SE	t	p
Buddhist	-0.27	0.08	-3.61	<.001
Christian	0.47	0.06	7.43	<.001
Hindu	0.20	0.07	2.70	<.01
Jewish	-0.09	0.10	-0.86	0.39
Muslim	0.37	0.06	5.62	<.001
None	-0.01	0.06	-0.18	0.86
Day Factor	<.005	<.005	0.70	0.48
Same Religion	-0.01	<.001	-9.80	<.001
Worse Day	-2.62	0.06	-44.77	<.001
Better Day	0.88	0.06	15.56	<.001

Table 13. Influence of Country on Well-Being

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Australia	-0.37	0.09	-4.13	<.001
Brazil	0.12	0.08	1.34	0.18
Burkina Faso	-0.29	0.09	-3.17	<.005
Canada	0.08	0.08	0.84	0.40
Chile	-0.92	0.09	-9.90	<.001
China	-0.84	0.07	-11.58	<.001
Ethiopia	0.62	0.09	6.80	<.001
France	-0.56	0.09	-6.14	<.001
Germany	-0.78	0.09	-8.48	<.001
Ghana	-0.28	0.09	-3.06	<.005
India	-0.76	0.08	-10.01	<.001
Indonesia	-0.66	0.09	-7.30	<.001
Israel	-1.07	0.09	-11.45	<.001
Italy	-0.98	0.09	-10.59	<.001
Japan	-1.33	0.09	-14.45	<.001
Jordan	-1.25	0.10	-12.81	<.001
Kenya	0.33	0.09	3.63	<.001
Lebanon	-1.35	0.10	-14.11	<.001
Malaysia	-0.47	0.09	-5.16	<.001
Mexico	-0.68	0.09	-7.45	<.001
Nigeria	0.48	0.09	5.40	<.001
Pakistan	0.05	0.08	0.61	0.54
Palestine	-0.93	0.09	-9.78	<.001
Peru	-0.04	0.09	-0.43	0.66
Philippines	-0.40	0.09	-4.40	<.001
Poland	-1.14	0.09	-12.45	<.001
Russia	-0.93	0.09	-10.11	<.001
Senegal	-0.95	0.09	-10.24	<.001
South Africa	-0.08	0.09	-0.89	0.37
South Korea	-1.22	0.09	-13.13	<.001
Spain	-1.17	0.09	-12.70	<.001
Tanzania	-0.62	0.09	-6.61	<.001
Turkey	-1.03	0.09	-10.95	<.001
Uganda	-0.51	0.09	-5.34	<.001
UK	-0.32	0.09	-3.50	<.001
Ukraine	-1.07	0.07	-13.55	<.001
United States	0.11	0.09	1.23	0.22
Venezuala	-0.29	0.09	-3.26	<.005
Vietnam	-0.79	0.09	-8.62	<.001

Worse Day	-3.31	0.07	-49.72	<.001
Better Day	0.30	0.06	4.74	<.001

Table 14. Influence of Religious Affiliation, Holy Day, and Level of Religious Similarity on Well-Being

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Christian	0.21	0.08	2.62	<.01
Muslim	0.49	0.08	6.39	<.001
Sunday	0.20	0.11	1.85	0.06
Friday	0.01	0.10	0.14	0.89
Similarity	-0.01	<.005	-3.96	<.001
Christian x Sunday	0.15	0.21	0.72	0.47
Christian x Friday	0.37	0.20	1.79	0.07
Christian x Similarity	<.01	<.005	2.40	0.02
Muslim x Sunday	0.15	0.20	0.79	0.43
Muslim x Friday	0.39	0.18	2.13	0.32
Muslim x Similarity	<-.001	<.005	-2.19	0.03
Sunday x Similarity	<-.001	<.005	-1.10	0.27
Friday x Similarity	<.005	<.005	1.16	0.25
Christian x Sunday x Similarity	<.005	<.01	0.23	0.82
Christian x Friday x Similarity	-0.01	<.01	-2.38	0.02
Muslim x Sunday x Similarity	<-.0001	<.01	-0.07	0.94
Muslim x Friday x Similarity	<-.005	<.005	-1.52	0.13
Worse Day	-2.54	0.04	-60.34	<.001
Better Day	0.95	0.04	24.30	<.001

Table 15. Topic Model Top Words

Top Words for Topic 18 Faith:

Highest Prob: thank, believ, faith, job, done, bibl, busi
FREX: thank, believ, faith, job, done, bibl, busi
Lift: cours, havent, kirstenpow, larg, link, recent, aaroncart
Score: thank, believ, faith, bibl, job, done, busi

Top Words for Topic 30 Islamophobia:

Highest Prob: world, muslim, yall, fuck, shit, place, islam
FREX: world, muslim, yall, fuck, shit, place, caus
Lift: acknowledg, ahahaha, alexjon, analyt, anytim, ayaw, bagay
Score: world, fuck, muslim, yall, shit, place, caus

Top Words for Topic 35 Christianity:

Highest Prob: will, jesus, mani, christ, turn, law, death
FREX: will, jesus, mani, christ, turn, death, hold
Lift: joke, actschrist, akbar, baba, baptiz, cancel, certifi
Score: will, jesus, christ, mani, turn, law, hahaha

Top Words for Topic 36 Prayer:

Highest Prob: god, pleas, help, pray, share, peac, young
FREX: god, pleas, help, pray, share, peac, young
Lift: abus, attent, ballpark, blasphem, brick, christen,
compliment
Score: god, pleas, help, pray, share, peac, spirit

Top Words for Topic 41 Support Conservatives:

Highest Prob: vote, pjnet, support, state, tcot, cruz, wish
FREX: vote, pjnet, support, state, tcot, cruz, wish
Lift: arabia, callisto, catwahl, chest, chooselif, deac, drottm
Score: pjnet, vote, support, tcot, state, ccot, cruz

Top Words for Topic 49 Never Trump:

Highest Prob: trump, donald, lie, nevertrump, gop, attack, elect
FREX: trump, donald, lie, nevertrump, elect, student
Lift: -minut, ark, asylum, backer, boomerjeff, bosnerdley,
brigad
Score: trump, donald, nevertrump, lie, gop, elect, attack

Table 16. Topic Model Estimates
(Reference is Sunday)

Topic 18: Faith

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Christian	0.0200	<.01	84.15	<.001
Muslim	0.0200	<.01	21.55	<.001
Monday	0.0003	<.01	0.59	0.55
Tuesday	0.0000	<.01	-0.03	0.98
	-			
Wednesday	0.0002	<.01	-0.52	0.60
Thursday	-0.0001	<.01	-0.16	0.87
Friday	0.0000	<.01	-0.02	0.99
Saturday	0.0001	<.01	0.31	0.75
Muslim x Monday	0.0002	<.01	0.11	0.92
Muslim x Tuesday	0.0012	<.01	1.15	0.25
Muslim x Wednesday	0.0006	<.01	0.60	0.55
Muslim x Thursday	-0.0001	<.01	-0.13	0.90
Muslim x Friday	0.0006	<.01	0.62	0.54
Muslim x Saturday	0.0006	<.01	0.58	0.56

Topic 30: Islamophobia

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Christian	0.0200	<.01	39.98	<.001
Muslim	0.0500	<.01	32.66	<.001
	-			
Monday	0.0003	<.01	-0.35	0.72
Tuesday	0.0011	<.01	1.64	0.10
Wednesday	0.0009	<.01	1.38	0.17
Thursday	0.0010	<.01	1.48	0.14
Friday	0.0035	<.01	5.62	<.001
Saturday	0.0037	<.01	5.44	<.001
	-			
Muslim x Monday	0.0085	<.01	-2.69	<.01
Muslim x Tuesday	-0.0135	<.01	-6.37	<.001
Muslim x Wednesday	-0.0160	<.01	-8.51	<.001
Muslim x Thursday	-0.0143	<.01	-6.66	<.001
Muslim x Friday	-0.0207	<.01	-10.47	<.001
Muslim x Saturday	-0.0149	<.01	-7.12	<.001

Topic 35: Christianity

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Christian	0.0200	<.01	83.68	<.001
Muslim	0.0200	<.01	20.04	<.001
Monday	-0.0013	<.01	-2.36	<.05
	-			
Tuesday	0.0007	<.01	-1.72	0.09
Wednesday	-0.0013	<.01	-3.44	<.001
Thursday	-0.0013	<.01	-3.23	<.005
Friday	-0.0021	<.01	-5.72	<.001
	-			
Saturday	0.0023	<.01	-5.71	<.001
Muslim x Monday	0.0023	<.01	1.28	0.20
Muslim x Tuesday	0.0006	<.01	0.48	0.63
Muslim x Wednesday	0.0020	<.01	1.84	0.07
Muslim x Thursday	0.0012	<.01	0.94	0.35
Muslim x Friday	0.0017	<.01	1.58	0.11
Muslim x Saturday	0.0021	<.01	1.78	0.07

Topic 36: Prayer

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Christian	0.0200	<.01	70.15	<.001
Muslim	0.0100	<.01	13.28	<.001
Monday	-0.0011	<.01	-1.94	0.05
Tuesday	-0.0011	<.01	-2.89	<.005
Wednesday	-0.0019	<.01	-4.88	<.001
Thursday	-0.0015	<.01	-4.07	<.001
Friday	-0.0015	<.01	-4.11	<.001
	-			
Saturday	0.0022	<.01	-5.52	<.001
Muslim x Monday	0.0093	<.01	5.20	<.001
Muslim x Tuesday	0.0033	<.01	2.81	<.01
Muslim x Wednesday	0.0058	<.01	4.92	<.001
Muslim x Thursday	0.0047	<.01	3.66	<.001
Muslim x Friday	0.0090	<.01	8.71	<.001
Muslim x Saturday	0.0075	<.01	5.82	<.001

Topic 41: Support Conservatives

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Christian	0.0300	<.01	40.85	<.001
Muslim	0.0082	<.01	4.17	<.001
Monday	0.0011	<.01	0.79	0.43
Tuesday	0.0023	<.01	2.37	0.02
Wednesday	0.0021	<.01	2.27	0.02

	-			
Thursday	0.0004	<.01	-0.41	0.68
	-			
Friday	0.0003	<.01	-0.28	0.78
Saturday	0.0001	<.01	0.15	0.88
Muslim x Monday	0.0002	<.01	0.05	0.96
	-			
Muslim x Tuesday	0.0009	<.01	-0.29	0.77
Muslim x Wednesday	0.0009	<.01	0.31	0.76
Muslim x Thursday	0.0044	<.01	1.41	0.16
Muslim x Friday	0.0044	<.01	1.62	0.11
Muslim x Saturday	0.0027	<.01	0.87	0.38

Topic 49: Never Trump

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Christian	0.0200	<.01	40.48	<.001
Muslim	0.0100	<.01	8.35	<.001
Monday	0.0006	<.01	0.56	0.57
Tuesday	0.0021	<.01	2.75	<.01
Wednesday	0.0049	<.01	6.47	<.001
Thursday	0.0022	<.01	2.68	<.01
Friday	0.0039	<.01	5.15	<.001
Saturday	0.0036	<.01	4.37	<.001
Muslim x Monday	0.0011	<.01	0.31	0.76
Muslim x Tuesday	-0.0012	<.01	-0.51	0.61
	-			
Muslim x Wednesday	0.0052	<.01	-2.25	0.02
	-			
Muslim x Thursday	0.0003	<.01	-0.10	0.92
	-			
Muslim x Friday	0.0033	<.01	-1.49	0.14
	-			
Muslim x Saturday	0.0038	<.01	-1.54	0.12

Table 17. Topic Model Top Words for State

Top Words for Topic 24 Politics:
 Highest Prob: will, trump, support, vote, parti, hillari, realdonaldtrump
 FREX: will, trump, support, vote, parti, hillari, realdonaldtrump
 Lift: agenda, cruzcrew, graham, nra, pjnet, teenchoic, -can
 Score: trump, will, vote, hillari, support, clinton, realdonaldtrump

Top Words for Topic 41 Positivity:
 Highest Prob: good, need, well, everyon, morn, phone, travel
 FREX: good, need, well, everyon, morn, phone, visit
 Lift: abak, abcbird, anatsfan, berger, bjp, bna, carmenmmachado
 Score: good, need, well, morn, everyon, phone, travel

Top Words for Topic 20 Negativity:
 Highest Prob: cant, never, wait, ive, nigga, ass, hit
 FREX: cant, never, wait, ive, nigga, ass, hit
 Lift: brad, fineartamerica, hurrican, idgaf, ozvan, paulmccartney, tristan
 Score: cant, never, wait, nigga, ive, ass, hit

Top Words for Topic 45 The Present:
 Highest Prob: now, tonight, week, final, state, retweet, friday
 FREX: tonight, week, final, friday, list, appreci, univers
 Lift: appreci, bibl, gofundm, knew, mansionelan, muscl, oop
 Score: now, tonight, week, final, state, friday, retweet

Table 18. Topic Model Estimates for State (Reference is Sunday)

Topic 24: Politics

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Low Attendance States	0.0347	<.01	66.06	<.001
High Attendance States	0.0275	<.01	68.00	<.001
Monday	-0.0006	<.01	-0.63	0.53
Tuesday	0.0002	<.01	0.27	0.79
Wednesday	0.0080	<.01	13.21	<.001
Thursday	0.0036	<.01	2.92	<.005
Friday	0.0068	<.01	10.41	<.001

Saturday	0.0074	<.01	10.11	<.001
HiAttendance x Monday	-0.0004	<.01	-0.30	0.76
HiAttendance x Tuesday	-0.0002	<.01	-0.24	0.81
HiAttendance x Wednesday	-0.0036	<.01	-4.48	<.001
HiAttendance x Thursday	-0.0027	<.01	-1.62	0.11
HiAttendance x Friday	-0.0045	<.01	-5.26	<.001
HiAttendance x Saturday	-0.0046	<.01	-4.75	<.001

Topic 41: Positivity

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Low Attendance States	0.0213	<.01	152.30	<.001
High Attendance States	0.0218	<.01	178.41	<.001
Monday	0.0005	<.01	2.23	0.02
Tuesday	-0.0001	<.01	-0.33	0.74
Wednesday	0.0003	<.01	1.84	0.07
Thursday	0.0009	<.01	2.57	0.01
Friday	0.0012	<.01	6.95	<.001
Saturday	0.0014	<.01	7.47	<.001
HiAttendance x Monday	0.0001	<.01	0.27	0.79
HiAttendance x Tuesday	-0.0001	<.01	-0.23	0.82
HiAttendance x Wednesday	-0.0004	<.01	-1.76	0.08
HiAttendance x Thursday	0.0000	<.01	0.07	0.94
HiAttendance x Friday	-0.0005	<.01	-2.03	0.04
HiAttendance x Saturday	-0.0007	<.01	-2.84	<.005

Topic 20: Negativity

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Low Attendance States	0.0184	<.01	112.66	<.001
High Attendance States	0.0223	<.01	158.67	<.001
Monday	0.0011	<.01	3.94	<.001
Tuesday	-0.0005	<.01	-1.99	0.05
Wednesday	-0.0007	<.01	-4.04	<.001
Thursday	-0.0002	<.01	-0.43	0.67
Friday	-0.0008	<.01	-4.04	<.001
Saturday	-0.0005	<.01	-2.32	0.02
HiAttendance x Monday	0.0000	<.01	0.13	0.90
HiAttendance x Tuesday	0.0006	<.01	1.91	0.06
HiAttendance x Wednesday	-0.0001	<.01	-0.34	0.73
HiAttendance x Thursday	0.0010	<.01	1.76	0.08
HiAttendance x Friday	0.0003	<.01	0.97	0.33
HiAttendance x Saturday	-0.0001	<.01	-0.27	0.79

Topic 45: The Present

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Low Attendance States	0.0187	<.01	120.26	<.001
High Attendance States	0.0207	<.01	159.84	<.001
Monday	0.0010	<.01	3.53	<.005
Tuesday	0.0000	<.01	-0.18	0.86
Wednesday	0.0014	<.01	7.81	<.001
Thursday	0.0022	<.01	6.11	<.001
Friday	0.0026	<.01	13.19	<.001
Saturday	0.0025	<.01	11.30	<.001
HiAttendance x Monday	-0.0008	<.01	-2.05	0.04
HiAttendance x Tuesday	-0.0001	<.01	-0.47	0.64
HiAttendance x Wednesday	-0.0004	<.01	-1.81	0.07
HiAttendance x Thursday	-0.0010	<.01	-2.01	0.04
HiAttendance x Friday	-0.0006	<.01	-2.47	0.01
HiAttendance x Saturday	-0.0006	<.01	-2.08	0.03

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