Happy Tweets: Christians Are Happier, More Socially Connected, and Less Analytical Than Atheists on Twitter

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Abstract

We analyze data from nearly 2 million text messages (tweets) across over 16,000 users on Twitter to examine differences between Christians and atheists in natural language. Analyses reveal that Christians use more positive emotion words and less negative emotion words than atheists. Moreover, two independent paths predict differences in expressions of happiness: frequency of words related to an intuitive (vs. analytic) thinking style and frequency of words related to social relationships. These findings provide the first evidence that the relationship between religion and happiness is partially mediated by thinking style. This research also provides support for previous laboratory studies and self-report data, suggesting that social connection partially mediates the relationship between religiosity and happiness. Implications for theory and the future of social science using computational methods to analyze social media are discussed.

Keywords

Twitter, religion, atheism, happiness, thinking style

Karl Marx (1843/1970) famously asserted that religion is ‘‘the opium of the people.’’ Though he recognized that religion can provide comfort in difficult circumstances, for Marx these benefits were an illusion. The idea that religion hinders true happiness is echoed by more recent arguments that the world would be a better place without religion (e.g., Dawkins, 2006; Harris, 2008; Hitchens, 2007). But there is also evidence for a positive correlation between religion and well-being (Ferriss, 2002; Hackney & Sanders, 2003; Koenig & Larson, 2001; Poloma & Pendleton, 1990), observed across all four major world religions (Buddhism, Christianity, Hinduism, and Islam; Diener, Tay, & Myers, 2011).

In the present research, we use Twitter data to examine two related research questions: (1) What is the relationship between religion and happiness? and (2) what particular aspects of religion contribute to this relationship? We investigate these ques-tions in a content analysis of Twitter messages (tweets) written by religious and nonreligious individuals. This approach has several important advantages. First, unlike traditional studies that assess happiness through self-report (i.e., directly asking participants how happy they are or to recall recent positive and negative emotion; Diener, Suh, Lucas, & Smith, 1999), Twitter data allow researchers to observe the mood of users by the expression of hap-piness (or unhappiness) in natural language. Twitter users are not directed by survey questions or responding in a laboratory setting that can trigger demand characteristics and distort accurate responses. Instead, Twitter users are casually conversing on the Internet with others on topics ranging from the mundane (e.g., ‘‘I just saw a chicken cross the road’’) to life changing (e.g., ‘‘I'm getting married!’’). Twitter can therefore provide a window into users' state of mind, in real time, as changes and events are experienced. Furthermore, Twitter.com is currently the ninth most popular website in the world, yielding millions of tweets per day from an extremely large and diverse pool of users (Alexa, 2012). Twitter thus provides a unique opportunity to study psychological constructs on a large scale that is not possible through traditional survey and laboratory methods (Lazer et al., 2009). Finally, content analysis of Twitter allows us to examine the linguistic markers of numerous different psychological vari-ables and their interrelationships simultaneously. In the present research, we investigated two independent mechanisms that may help explain the association between religion and happiness—analytical thinking style and social connection—also observable by differences in language use.

Thinking Style and Social Connection as Mediators

Whether religious people experience more or less happiness is an important question in itself. But to truly understand how religion and happiness are related we must also understand why the two may be related. What features of religion could produce

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differences in happiness? We explored two independent mechanisms that may mediate the relationship between religion and happiness. First, believers and nonbelievers may differ in preference for an intuitive versus analytical thinking style (Gervais & Norenzayan, 2012; Shenhav, Rand, & Greene, 2011). Whereas intuitive thinking relies on gut feelings to make decisions, an analytical thinking style emphasizes criticism and skepticism to draw conclusions (Frederick, 2005). It is easy to see how differences in thinking style may be associated with religious belief. Faith is often characterized by strong emotional conviction and valued by the very virtue of its uncritical nature. In contrast, religious disbelief can be characterized by its skeptical approach to belief. Many scholars suggest that the belief in God is a cogni-tive default for humans (Barrett, 2000; Bloom, 2007), and thus analytical thinking and skepticism may be necessary for one to reject the dominant belief in God. More important here, however, these differences in thinking style may contribute to differences in happiness. At its extreme, analytic thinking can foster intense rumination that can contribute to depression (Andrews & Thomson, 2009). Analytical thinking may also diminish the capacity for optimism and positive self-illusions that typify good mental health (Taylor & Brown, 1988). If religious people are indeed happier than nonreligious people, differences in thinking style may help explain why. But to our knowledge, no previous research has tested this prediction. Here, we examined whether nonreligious people exhibit more analytical thinking in their tweets compared to religious people and whether this could predict differences in happiness between the two groups.

We were also interested in the role of social relationships as a mediator between religion and happiness. Several lines of study have suggested that the quality of social relationships contribute to overall happiness and well-being (Diener & Selig-man, 2002; Lyubomirsky, King, & Diener, 2005; Myers, 2000). Religion frequently provides a tight-knit moral community in whom group members can trust and depend on for social support (Graham & Haidt, 2010). In other words, religious people benefit by being surrounded by an extended ‘‘family’’ with whom they can share in life’s joys and endure its trials. Consistent with this idea, religious people report having stron-ger social relationships than less religious people, and this difference in social support predicts happiness (Diener et al., 2011; Salsman, Brown, Brechting, & Carlson, 2005). Another goal of the present research was to investigate whether this effect could be observed in natural language on Twitter.

Method

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study (Simmons, Nelson, & Simonsohn, 2012).

Procedure

All data were collected using Python v2.7.3, a freely available and open-source programming language. We gained access to the Twitter Application Programming Interface using the Twython package for Python (McGrath, 2012).[1]

Christian and atheist Twitter users were selected for analysis by sampling from those who elected to follow the Twitter feeds of five Christian public figures or five atheist public figures. The five Christian public figures were Pope Benedict XVI (@PopeBXVI), Dinesh D’Souza (@DineshDSouza), Joyce Meyer (@JoyceMeyer), Joel Osteen (@JoelOsteen), and Rick Warren (@RickWarren). The five atheist public figures were Richard Dawkins (@RichardDawkins), Sam Harris (@SamHarrisOrg), Christopher Hitchens (@ChrisHitchens), Monica Salcedo (@Monicks), and Michael Shermer (@MichaelShermer). The most recent tweet in the sample was from October 1, 2012.

For each of these 10 public figures, we first obtained a list of their followers and shuffled them into random order. Followers and their timelines (i.e., recent tweets) were then sampled from this list at a rate of 150 per hr for a 24-hr period, resulting in 3,600 possible follower timelines per public figure. Only publicly available follower timelines were accessed and up to 200 of each follower’s most recent tweets were collected. This process resulted in timelines from a total of 12,849 Christian followers and 13,367 atheist followers. However, many of these followers had relatively few tweets in their timeline and/or did not report English as their language. The final sam-ple thus included the 7,557 Christian followers (877,537 tweets) and 8,716 atheist followers (1,039,812 tweets) who self-reported English as their language and had at least 20 tweets in their timeline. Thirteen followers who met all of these criteria were following both a Christian and an atheist public figure in our sample and were excluded from the final analysis. Prior to analysis, each follower timeline was cleaned by converting all words to lowercase and removing numbers, hyperlinks, punctuation (except apostrophes), and any mention of another Twitter user (e.g., @<username>).

The majority of users in our sample either did not self-report their location (n = 5,252) or reported a time zone in the United States or Canada (Atlantic = 464; Eastern = 2,377; Central = 1,916; Mountain = 472; Arizona = 268; Pacific = 1,238; Hawaii = 226; and Alaska = 164). The rest of the users reported locations more sparsely distributed across the world (e.g., London = 895; Quito = 607; Amsterdam = 263; Beijing ¼ 63; Mumbai = 24; Jerusalem = 14).

Measures

Christian and atheist follower timelines were analyzed using Linguistic Inquiry and Word Count (LIWC; Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007), a computerized text analysis program. Given a piece of text, LIWC counts the frequency of words or word stems present in a given language category and outputs the percentage of words that appear in each category. The LIWC dictionary includes subdictionaries measuring objective linguistic categories (e.g., pronouns, articles, and adverbs) as well as a variety of psychological pro-cesses (e.g., affective, cognitive, and perceptual) and personal

Table 1. Descriptive Statistics and Zero-Order Correlations.

LIWC Category	M	SD	Religion	Social Processes	Happiness	Positive Emotion	Negative Emotion
Christian followers							
Religion	1.12	1.59	—				
Social	9.36	3.17	0.18**	—			
Happiness	3.45	2.68	0.09**	0.22**	—		
PosEmo	5.53	2.31	0.01	0.34**	0.90**	—	
NegEmo	2.08	1.16	0.19**	0.16**	0.52**	0.10**	—
Insight	1.54	0.78	0.03	0.27**	0.06**	0.05**	0.25**
Atheist followers							
Religion	0.73	1.16	—				
Social	8.08	2.91	0.14**	—			
Happiness	2.44	2.25	0.14**	0.11**	—		
PosEmo	4.77	1.93	0.09**	0.29**	0.86**	—	
NegEmo	2.33	1.15	0.12**	0.27**	0.51**	0.00	—
Insight	1.78	0.90	0.18**	0.27**	0.08**	0.04*	0.21**

Note. LIWC = Linguistic Inquiry and Word Count; M = mean; SD = standard deviation.
Means are expressed as the percentage of total words within follower time lines. Happiness is operationalized as the difference in negative emotion from positive emotion.
*p < .01. **p < .001.

processes (e.g., work, religion, and leisure). The LIWC diction-ary has been extensively developed and validated (for a detailed description, see Pennebaker et al., 2007) and has been successfully applied to the measurement of a wide variety of constructs (for a review, see Tausczik & Pennebaker, 2010). For example, LIWC reliably detects the positive and negative emotion words used when people are asked to write about positive and negative life events (e.g., Kahn, Tobin, Massey,
& Anderson, 2007) and correlates with human judgments of affective content (e.g., Pennebaker & Francis, 1996). In a recent investigation on Twitter, researchers used LIWC to mea-sure within-person fluctuations in affect and found that people tend to be happiest early in the mornings and on the weekends (Golder & Macy, 2011).

Happiness. The presence of positive emotions and the absence of negative emotions each have an independent influence on happiness (Diener & Emmons, 1984). Here, we operationalized happiness as the relative frequency of words in LIWC's posi-tive emotion dictionary (e.g., ''love,'' ''nice'') to the frequency of words in the negative emotion dictionary (e.g., ''hurt,'' ''nasty''). In addition, we examined the independent effects of positive and negative emotion, respectively.

Social Connection and Thinking Style. Social connection was mea-sured as the frequency of words in LIWC's social processes dictionary (e.g., ''mate,'' ''friend'') and analytic thinking was measured using the dictionary of insight words (e.g., ''think,'' ''consider''). These dictionaries were developed and validated using the same procedures as the affective dictionaries described above (Pennebaker et al., 2007) and have also been used in previous research (e.g., Pennebaker & Francis, 1996).

Religion. We compared the frequency of words in LIWC's religion dictionary (e.g., ''God,'' ''church'') to validate our assumptions about Christian and atheist followers' own reli-gious beliefs. The religion dictionary was developed along with the other LIWC subdictionaries.

To avoid any artificial inflation of association among these variables, we removed a total of 43 words or word stems that appeared in more than one of the five LIWC dictionaries of interest (positive emotion, negative emotion, social processes, insight, and religion). For example, in the unmodified LIWC 2007 dictionary, the stem ''bless*'' is included in both the pos-itive emotion and the religion categories, and the stem ''prais*'' is included in the social processes, positive emotion, and reli-gion categories. We therefore excluded these 43 words and word stems, so that common phrases (e.g., ''praise God,'' ''God bless'') did not artificially bias the results.[2]

Results

Sample Validation

Table 1 provides descriptive statistics and correlations among all the variables of interest. Christian and atheist followers did not differ in the percentage of all words captured by the LIWC dictionary (grand mean = 74.47, $p = .70$), suggesting that differences in linguistic content cannot be accounted for by simple differences in English proficiency.

As expected, Christian followers tweeted words in LIWC's religion dictionary more frequently than atheist followers, $F(1, 16271) = 328.51$, $p < .001$; Cohen's $d = .29$, and talking about religion was associated with less negative affect among Christian followers ($r = .19$, $p < .001$). Conversely, increased chatter about religion among atheist followers was associated with more negative ($r = .12$, $p < .001$) and less positive affect ($r = .09$, $p < .001$). These results suggest that the selection of Christian/atheist followers was indeed a valid measure of belief/nonbelief.

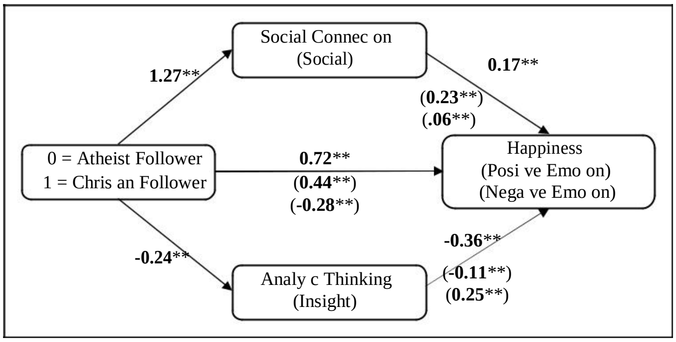

Figure 1. Indirect effects of religious belief on happiness through social connection and analytic thinking. Values above the paths repre-sent effects on happiness (positive emotion minus negative emotion); values in parentheses below the paths represent effects on positive emotion and negative emotion, respectively. LIWC dictionary names are in parentheses. LIWC = Linguistic Inquiry and Word Count.
$^{**}p < .001$.

Main Analyses

Because of our large sample, we adopted a significance criter-ion of $p < .01$ for all analyses. We tested a multiple mediator model using PROCESS with 10,000 bootstrapped samples (Hayes, 2012), where religious belief (Christian follower = 1, atheist follower = 0) was used to predict happiness with social connection and thinking style included as mediators. We also analyzed the data separately using positive emotion and negative emotion as outcomes to investigate the independent components of happiness.

First and foremost, the predicted relationship between religion and happiness was supported. Relative to the atheist followers, Christian followers expressed more happiness in their tweets (total effect = 1.01, standard error [SE] = .04, $t = 26.21$, $p < .001$; Cohen's $d = .41$), reflected in the expres-sion of more positive emotion (total effect = 0.76, SE = .03, $t = 22.88$, $p < .001$; Cohen's $d = .36$) and less negative emotion (total effect = 0.25, SE = .02, $t = 13.95$, $p < .001$; Cohen's $d = .22$; see Table 1 for means). Second, as seen in Figure 1, we found evidence that this relationship is partially mediated by social connection. Christians talked more about social pro-cesses than atheists ($b = 1.27$, SE = .05, $t = 26.73$, $p < .001$; Cohen's $d = .42$), which in turn was associated with more hap-piness ($b = 0.17$, SE = .01, $t = 25.51$, $p < .001$; $b_{Positive\ Emotion}$ ¼ 0.23, SE = .01, $t = 42.56$, $p < .001$; $b_{Negative\ Emotion} = 0.06$, SE = .003, $t = 21.44$, $p < .001$). On average, 9.36% of words used by Christian followers were related to social processes, compared to 8.08% among atheist followers, consistent with the hypothesis that religion promotes social support and social connectivity (see Table 1). Indeed, social connection partially mediated the effect of religious belief on happiness (indirect effect = 0.21, 99% confidence interval [CI] = [0.17, 0.26]; indirect effect$_{Positive\ Emotion}$ = 0.29, 99% CI = [0.23, 0.34]; indirect effect$_{Negative\ Emotion}$ = 0.08, 99% CI = [0.06, 0.10]).

Next, we investigated differences in thinking style. Atheist followers were more likely than Christian followers to use ''insight'' words ($b =$ 0.24, SE = .01, $t =$ 17.92, $p < .001$; Cohen's $d = .28$), consistent with predictions that athe-ists use a more analytical thinking style (see Table 1 for means). As seen in Figure 1, analytic thinking was then associ-ated with less happiness ($b = 0.36$, SE = .02, $t = 15.53$, $p < .001$; $b_{Positive\ Emotion} = 0.11$, SE = .02, $t = 5.90$, $p < .001$; $b_{Negative\ Emotion} = 0.25$, SE = .01, $t = 23.01$, $p < .001$). Use of insight words also partially mediated the association between belief and happiness (indirect effect = .09, 99% CI = [.06, .11]; indirect effect$_{Positive\ Emotion}$ = 0.03, 99% CI = [0.01, 0. 05]; indirect effect$_{Negative\ Emotion}$ = 0.06, 99% CI = [0.07, 0.05]). Follow-up analyses revealed another mean-ingful pattern of thinking style: Christians and atheists differed in the kinds of insight words used, independent of mean-level differences. Christian followers were more likely to use insight words best characterized by certainty and emotion (e.g., ''know,'' ''feel''), whereas atheist followers were more likely to use insight words characterized by skepticism and analysis (e.g., ''thought,'' ''reason;'' see Figure 2).[3] This interpretation was further supported with follow-up analyses of the LIWC dictionaries measuring tentativeness (e.g., ''maybe,'' ''per-haps'') and certainty (e.g., ''always,'' ''never''). The percentage of words expressing tentativeness was lower among Christian tweets ($M = 1.70$, standard deviation [SD] = .84) than atheist tweets, $M = 2.02$, $SD = .94$; $F(1, 16271) = 506. 72$, $p < .001$; Cohen's $d = .36$. On the flip side of this effect, the percentage of words expressing certainty was higher among Christian tweets ($M = 1.37$, $SD = .71$) than atheist tweets, $M = 1.34$, $SD = .75$; $F(1, 16271) = 6.27$, $p = .01$; Cohen's $d = .04$. These findings are consistent with previous evidence that atheists have a more analytical thinking style, whereas believers prefer an intuitive thinking style.

Discussion

In a linguistic analysis of nearly 2 million text messages (tweets) across 16,273 users on Twitter, we found that Christians express more happiness than atheists in everyday language. This relation was partially mediated by linguistic markers of social connection and thinking style. Christians were more likely to mention social processes that suggest stronger relationships and support networks. Simultaneously, atheists were more likely to use ''insight'' words (e.g., ''think,'' ''reason'') that in turn predicted decreased happiness, the first evidence that thinking style partially mediates the relation between religion and happiness.

Our results reveal important psychological differences between believers and nonbelievers, and also suggest reasons why believers may be happier than nonbelievers in general. However, these findings should not be taken to mean that religion is a prerequisite for happiness or that atheists are doomed to be miserable. Religion itself may not provide the key to happiness. Rather, religion can promote well-being through other factors. Such insights can be used to improve happiness in believers and nonbelievers alike. For example, atheists may improve happiness by creating strong social

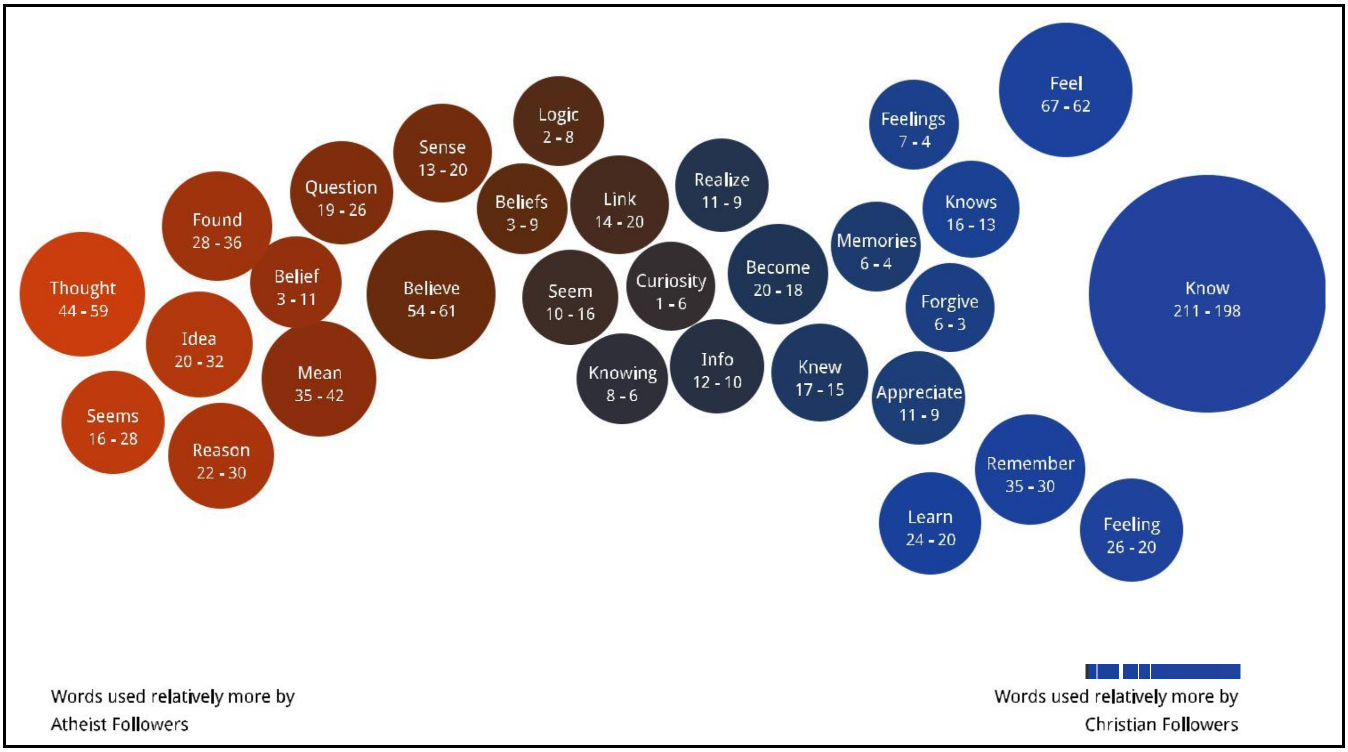

Figure 2. Top 30 differences in usage for words within the LIWC insight dictionary. To create this visualization, we first calculated the percentage usage of each word within the LIWC insight dictionary for both Christian and atheist followers. We next subtracted the atheist follower percentage from the Christian follower percentage for each word. Finally, we selected the 30 most divergent words for visualization: 15 representing those used relatively more often by Christian followers and 15 representing those used relatively more often by atheist followers. The sizes of the circles are scaled to represent overall word usage. The color of the circles and their position along the x-axis are scaled to represent relative word usage among Christian and atheist followers. Values indicate the number of mentions per 100,000 words, Christian Count–atheist Count. LIWC = Linguistic Inquiry and Word Count

communities and support networks. Currently, atheists are among the least trusted groups in American society (Gervais, Shariff, & Norenzayan, 2011) and are bound to experience some increased level of rumination and unhappiness due to the prob-lem of social exclusion. However, Atheism and secularism have increased in recent years (WIN-Gallup International, 2012), and the divergence in happiness between believers and nonbelievers may decrease as Atheism becomes more normative. Indeed, nonreligious people are equally happy as religious people in non-religious nations (i.e., where they fit in; Diener et al., 2011), and increasing the perceived prevalence of atheism can decrease anti-atheist prejudice (Gervais, 2011). In other words, increases in happiness among nonbelievers should parallel increases in the availability of secular social support resources and increased feelings of being respected in society, both of which facilitate increased happiness. Future research measuring Twitter activity in specific regions or nations (e.g., using self-reported location information along with geotagged information about the precise latitude and longitude of tweets) is encouraged to examine questions related to person–culture fit.

It is important to note that there may be other mediators and variables that account for the relationship between reli-gion and happiness that are not captured by these particular analyses. For example, religion may help provide a meaning system to believers that resolves existential issues and helps buffer against anxiety (Inzlicht, Tullett, & Good, 2011), which is consistent with previous evidence that having pur-pose or meaning in life also mediates the association between religion and happiness (Diener et al., 2011). Here, proclivity for analytic thinking could hurt or help well-being. Atheists may come to some unpleasant conclusions on existential issues through analytical thinking, but they may also derive happiness and meaning from science as an elegant system of explanation (Preston, 2011; Preston & Epley, 2009). Addi-tionally, because we measured associations among these vari-ables simultaneously, we must be very cautious in interpreting causality. The associations reported may indeed be mutually reinforcing and could have causal influences opposite the directions modeled here. For example, having a strong social support network and meaningful relationships may cause hap-piness, but being happy also causes people to have better social relationships (Lyubomirsky et al., 2005). Future research could address these limitations of causal inference by including time as a variable, or by complementing Twitter analyses with traditional laboratory-based research methods that afford more experimental control.

The present studies demonstrated powerful effects by accessing millions of messages available on Twitter. This novel method allows meaningful patterns to emerge in the specific words people choose to use in tweets, rather than relying on more traditional self-report methods. Twitter has considerable advantages as a source of data—its massive scale, ease of access, high external validity, and fewer demand characteristics. But of course, it is not without limitations. First, Twitter users may still engage in some impression management strategies. Sampling moments are not random and users can decide exactly what they want to tweet about and when, meaning people can selectively control the content they want others to see. This concern is at least partially alleviated by the fact that Twitter users have no way to know what kind of research their data may be used for, if at all. There is thus little concern about the expectations of an experimenter and the impressions one might make on them.

It is also important to acknowledge that sampling from followers of major public figures—particularly those on the far extremes of religious belief and disbelief—may not represent typical Christians or atheists, and these effects could reflect a comparison of extremely conservative Christians to militant atheists. We have also operationalized Christians and atheists as those who chose to follow public figures well known for their beliefs. But of course, people can follow these public figures for reasons wholly unrelated to their religion. Despite the imperfect nature of this sampling method, the large-scale nature of Twitter data appears robust. Given that we randomly sampled from literally millions of possible followers, it is reasonable to expect a distribution that includes extreme believers and nonbelievers as well as those with more moderate or indifferent attitudes toward religion. Most importantly, we are encouraged by the utility of Twitter data insofar as it corroborates previous research that has used both laboratory-based experimental studies (e.g., Shenhav et al., 2011) and nationally representative samples (Diener et al., 2011). This convergence suggests that the present findings are not limited solely to Christian and atheist extremists and that Twitter can be used to derive novel insights into a variety of phenomenon of interest to social psychologists.

A final important limitation of the present research—but one that is not unique to Twitter data—is the inherent limitation of computerized text analysis. The analyses here relied on simple word counts, and cannot account for complex features of language such irony or sarcasm, and are insensitive to con-text (e.g., Tweeting about positive things even when unhappy). People may also negate their use of positive or negative affect words (e.g., ''not good'' and ''not bad'') to convey a valence opposite to what would be coded by a computer. To address this possibility, we removed from user's Twitter time lines all instances of words in the positive and negative emotion dictionaries that were preceded by ''no'' or ''not'' (see also, Golder & Macy, 2011). Rerunning the analyses on these data did not significantly alter the results. Thus, despite some important limitations of Twitter data, we argue that the benefits of using computational methods to access large-scale ''real-world'' data far outweigh the costs, especially when complemen-ted by more traditional research methods.

Conclusion

Overall, the present research demonstrates a positive relationship between religion and happiness that can be observed in subtle differences in language use. This research also sheds light on some of the underlying reasons for this relationship, that is, that religious people have stronger social connections that can promote positive well-being and that atheists engage in a more analytical thinking style that can diminish well-being. More broadly, these results reveal the power of Twitter data as an important research tool. Linguistic markers of psychological phenomena reliably emerge even in casual Internet conversations. Twitter data can provide valuable insight into complex psychological processes and should be considered a powerful tool for social scientists as people increasingly live their lives online.

Authors' Note

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Notes

1. Example Python code can be obtained from the first author upon request.
2. Running the analyses using the unmodified Linguistic Inquiry and Word Count (LIWC) 2007 dictionary yields the same pattern of results. The biggest difference in using the unmodified dictionary is that, among the Christian followers, religion and positive emotion are positively correlated, $r = .17$, $p < .001$.
3. An interactive visualization of within-dictionary differences for all LIWC dictionaries of interest is available at the following website (requires Java to view): http://labs.psychology.illinois.edu/pramlab/ SPPS_ForceGraph/

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