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Seasonal Variation in Internet Keyword Searches: A Proxy Assessment of Sex Mating Behaviors

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Abstract The current study investigated seasonal variation in internet searches regarding sex and mating behaviors. Harmonic analyses were used to examine the seasonal trends of Google keyword searches during the past 5 years for topics related to pornography, prostitution, and mate-seeking. Results indicated a consistent 6-month harmonic cycle with the peaks of keyword searches related to sex and mating behaviors occurring most frequently during winter and early summer. Such results compliment past research that has found similar seasonal trends of births, sexually transmitted infections, condom sales, and abortions.

Keywords Sex · Pornography · Google · Keyword · Seasonal

Introduction

Individuals often utilize the internet as a means of finding potential mates and even acquiring sexual gratification (e.g., finding pornography, engaging in prostitution, obtaining romantic partners, etc.). Past research on these topics has tended to focus on various predictors of *who* engages in these behaviors (e.g., Cooper, Delmonico, & Burg, 2000; Ybarra & Mitchell, 2005). For example, customers of prostitutes tend to be younger, less educated, and even weigh less than men in the general population (Brewer, Muth, Roberts, Dudeck, & Woodhouse, 2007). Relatively little research has been conducted to determine *when* individuals utilize the

internet for sexual gratification or to find potential mates. The current research examined seasonal trends of internet activity related to sex and mate-seeking behaviors in order to better understand and predict these activities.

In an effort to discover a seasonal trend in sex behaviors, Seiver (1985) conducted a comprehensive examination of 30 years of birth records in the United States and concluded that children tend to be conceived more frequently in winter months (especially December) than during any other month (see also Lam & Miron, 1991; Scafetta, Restrepo, & West, 2003; Tita, Hollier, & Waller, 2001). Consistent with this notion, it has been found that there tends to be an increase in abortions during the first quarter of any typical year (Parnell & Rodgers, 1998; Warren, Gold, Tyler, Smith, & Paris, 1980; Wellings, Macdowall, Catchpole, & Goodrich, 1999). Given that the majority of abortions occur during the first 8 weeks of pregnancy (Elam-Evans et al., 2002), this increase could be partially explained due to an increase in sexual activity during the winter holiday season.

In addition to the apparent increase of coitus during the winter months, there also appears to be an increase in sexual activity during early summer (Fortenberry, Orr, Zimet, & Blythe, 1997; Petersen & Alexander, 1992; Warren et al., 1980). Condom sales tend to show a bimodal pattern, with peak sales occurring around Christmas week and during the summer months (Wellings et al., 1999). An increasing number of studies have found a seasonal effect of first intercourse, with one peak occurring in December and the other in May and June (Levin, Xu, & Bartkowski, 2002; Pittman, Tita, Barratt, Rubin, & Hollier, 2005; Rodgers, Harris, & Vickers, 1992). As a possible outcome of such sexual activity, various STIs (e.g., herpes, syphilis, trichomoniasis, HIV, etc.) are often diagnosed in the months following Christmas and in late summer-early fall (Herold et al., 1993; Schroeder, Tetlow, Sanfilippo, & Hertweck, 2001; Wellings et al., 1999).

Taken together, this research suggests that sex and mating behaviors in the United States show a 6-month seasonal cycle, with peaks during the winter months and during the early summer (for a

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review see Macdowall, Wellings, Stephenson, & Glasier, 2008). These two peaks in sexual activity have been termed the *holiday season effect* and the *summer vacation effect,* respectively (Levin et al., 2002; Rodgers et al., 1992). The exact cause of these two peaks is somewhat unclear, with explanations including: the quality of sperm during certain times of the year, a general increase in libido due to hormonal changes, tax laws, festival and holiday times, and preferred seasons of birth (see Macdowall et al., 2008).

Following a comprehensive review on seasonal variations in sexual activities among young people, Macdowall et al. (2008) noted that the majority of previous studies examining this topic have only inferred seasonal changes in sex and mating behaviors via various outcomes that occur months after coitus had occurred (e.g., birth records, STI rates, abortion rates, etc.). Although this information is both interesting and valuable, it is also important to examine more immediate assessments of sex and mating behaviors. It is likely that such assessments are rare due to the immense amount of data needed to detect seasonal trends and because of the difficulty of obtaining accurate self-report data related to sex and mating behaviors (Tourangeau & Yan, 2007). Another possible limitation of the methodologies employed in previous research is that future changes in sex and mating trends would likely take years to detect. Given the important link between sexual activity and STIs, it would be desirable to detect changes in sexual activity as quickly as possible. In other words, it would be ideal to obtain a set of data across several years that provide a real time assessment of interest in sex and mating behaviors and that could also be used to quickly discover future changes in these patterns.

One means of measuring what sexual issues and concerns are on the public's mind at a specific period of time is by assessing changes in internet keyword searches. By simply typing a few words into an internet search engine (e.g., Google), individuals are able to obtain information on any topic of interest. For example, a person might type the word "porn" into the Google search engine when attempting to find pornography. A person might type in "eHarmony" when trying to find a mate or even "prostitute" when attempting to engage in illicit sexual activities. Given that about 78 % of the population in the United States has access to the internet (World Bank, 2011), web search queries have become a valuable source of information about what issues, concerns, and desires individuals residing within the United States are thinking about. One efficient means of assessing changes in keyword searches is via the web service Google Trends (Google, 2009). In addition to providing a measure of keyword usage from the past several years, Google Trends supplies weekly reports on the volume of queries so changes in these keyword searches can be detected fairly quickly. Past researchers have successfully used Google Trends to examine seasonal affect disorder (Yang, Huang, Peng, & Tsai, 2010), to track H1N1 outbreaks (Ginsberg et al., 2009), suicide (McCarthy, 2010), and even pornography searches following political elections (Markey & Markey, 2010, 2011).

Google Trends was used in the current study to examine seasonal changes in keyword searches related to sex and mating

behaviors. Specifically, three different categories of sex and mating behaviors were examined: pornography, prostitution, and mate-seeking. These categories were selected because individuals often utilize the internet to engage in these activities and because they represent different modes of sex and mating behaviors. Men often utilize pornography as a means of providing physical gratification without commitment (Malamuth, 1996). Although pornography use does not have any adverse health effects related to STIs or unwanted pregnancies, in the current analysis pornography searchers were conceptualized as a proxy measure of sex drive (Baumeister, Catanese, & Vohs, 2001). Prostitution-seeking via the internet provides an efficient means for clients to find escorts and for escorts to market their services Finally, unlike pornography and prostitution, which are typically male focused activities (Baumeister et al., 2001), a considerable number of men and women utilize various online dating sites (e.g., eHarmony, Match.com, etc.) in order to seek potential mates (Fallows, 2005).

The current study examined whether or not these three sex and mating behavior categories produced similar seasonal patterns. The examination of these three modes of sex and mating behaviors is important because, if similar trends are found for all three activities, this would likely reflect a general trend in sexual desire and activity instead of a trend specific to a given activity. As noted elsewhere (Markey & Markey, 2012), whenever keyword search trends are examined, it is important to compare the results yielded from a category of keywords against a control set of keywords. Such a comparison allows one to determine if the observed trend was unique for keywords related to sex and mating behaviors or if it simply reflects general changes in the use of Google across time. Therefore, in the current research, three different categories of keyword searches were created in order to serve as "control" conditions. Given extensive research suggesting that sex behaviors in the United States show biseasonal trends, it was expected that only the keyword searches related to sex and mating behaviors would show a 6 month cycle with peaks occurring in winter (the holiday effect) and early summer (the summer vacation effect).

Method

Participants

Participants for this study were any individuals residing in the United States who entered select keywords into the Google search engine between January 2006 and March 2011.

Measurements

Sex and Mating Behavior Keywords

In order to examine keyword searches for pornography, prostitution, and mate-seeking, different sets of keywords were selected. The pornography keyword set included 10 keywords used in previous research that individuals tend to use when searching for

pornography ("porn,""boobs,""xvideos,""tits,""sex,""pussy," "hentai,""xxx,""nude," and "milf"; see Markey & Markey, 2010, 2011). In a similar manner, the prostitution keyword set included five keywords that individuals might use to engage in sexual activities that are often illegal ("call girl," "escort," "massage parlor," "brothel," and "prostitute"). Finally, the mate-seeking keyword set included the names of 10 popular websites that individuals often use to find potential mates ("eHarmony,""Yahoo Personals", "AOL Personals," "Plenty of Fish," "Zoosk," "Singles Net" "Friend Finder," "JDate,""Match.com," and "Okcupid").

Control Keywords

In selecting the categories of control keywords, we attempted to choose keyword sets that did not have any inherent seasonal trends (e.g., Christmas keywords, weather keywords, depression, etc.). For each keyword set, seven keywords were selected and the categories were: *pets* ("dog," "cat," "hamster," "fish," "snake," "ferret," and "bird"), *popular websites* ("Yahoo," "Facebook," "Youtube," "Hotmail,""Google,""MySpace," and "ebay"), and *car parts* ("tires,""brakes,""windshield,""hood,""engine,""headlight," and "horn").

Procedure

Google Trends was utilized to determine how often individuals searched for these different keyword sets between January 2006 and March 2011. To do this, Google Trends examines Google web searches to determine how many searches for a given set of keywords had been conducted in a given week relative to the average number of searches on Google for those keywords over the observed time period. Although Google Trends does not supply the raw number of searches that occurred, the information it provides allows for the computation of a Relative Search Volume Index (RSVI). This value represents the percent increase of searches for a set of keywords relative to the norm (Google, 2009; Markey & Markey, 2010, 2011). The interpretation of a RSVI is fairly straightforward. A RSVI score of 0 % indicates the search volume for a given keyword set was equivalent to the norm in a given time period. A RSVI score of 2 % indicates that the search volume for a given keyword set was 2 % higher than the norm, and a RSVI score of −2 % indicates the search volume for a keyword set was 2 % lower than the norm in a given time period.

In the current study, RSVI was computed for each keyword set (i.e., pornography prostitution, mate-seeking, pets, popular websites, and car parts) each week between January 2006 and March 2011. Because the main interest in this study was examining monthly changes in keyword searching behaviors, RSVI values for each week were aggregated into monthly scores. Therefore, for each keyword set, there were 63 monthly RSVI scores.

A preliminary examination of these data revealed no outliers for any of the keyword sets, except for prostitution. During March 2008, there was a dramatic 35 % increase in searches for keywords about prostitution. Such an increase likely occurred because, on March 10, 2008, the Eliot Spitzer prostitution scandal began, which ultimately led to his resignation as governor of New York (Hakim & Rashbaum, 2008). Such an occurrence demonstrates how Google Trends can be used to obtain a "snap shot" of what's on the public's mind at any given moment in time. Although this anomalous event is interesting, it is likely unrelated to any cyclical trend. Therefore, the RSVI value for prostitution that occurred on this date was replaced with the mean RSVI value for the month before and the month after this date.

Results

In the following analyses, the focus was examining biseasonal changes that occurred in any of the keyword sets. Therefore, all of the data were de-trended by removing any variance which was attributed to linear trends. This allows the harmonic analysis to be conducted and removes any artifacts in the results that might be due to the general increase in popularity of Google (Warner, 1998). This was accomplished by regressing time on RSVI values, for each keyword set, and conducting all subsequent analyses on these residuals.

Figures 1, 2, and 3 display the monthly changes in searches related to pornography, prostitution, and mate-seeking each month for the period January 2006 to March 2011. Simple correlations computed between each of these keyword sets suggests the monthly changes in searches related to pornography and prostitution ($r = .55$), pornography and mate-seeking ($r = .69$), and prostitution and mate-seeking ($r = .57$) displayed similar patterns. More importantly for the current study, a visual inspection of these data suggest a relatively consistent biseasonal pattern of searching behaviors, with peaks occurring in the winter and summer months and troughs occurring in the Spring and Fall months. Harmonic analyses were next used in order to formally test the hypotheses in this study by modeling the cyclic component of these time series. This model assesses whether or not a time series shows regular, sinusoidal cycles, and was examined using the equation (Warner, 1998):

$$\chi_t = \mu + R \cos([2\pi/\tau]t + \varphi) + \varepsilon_t$$

where χ_t is the observed RSVI value at time t; μ is the mean level of the time series (in the current analysis, this will always be 0 %); R is the amplitude of the waveform (i.e., the height of the peaks and troughs of a cycle); φ is the location of peaks relative to time zero (this can be used to determine which months have the highest peaks); ε_t are residuals that are unrelated to the fitted cycles; t is the observation number; and τ is the length of the cycle (6 months). All the parameters in this model were estimated using OLS regression methods (Warner, 1998). The fit of this equation can be estimated using both a multiple R and an R^2, with high R^2 values indicating that the model accounted for a large amount of the observed variance.
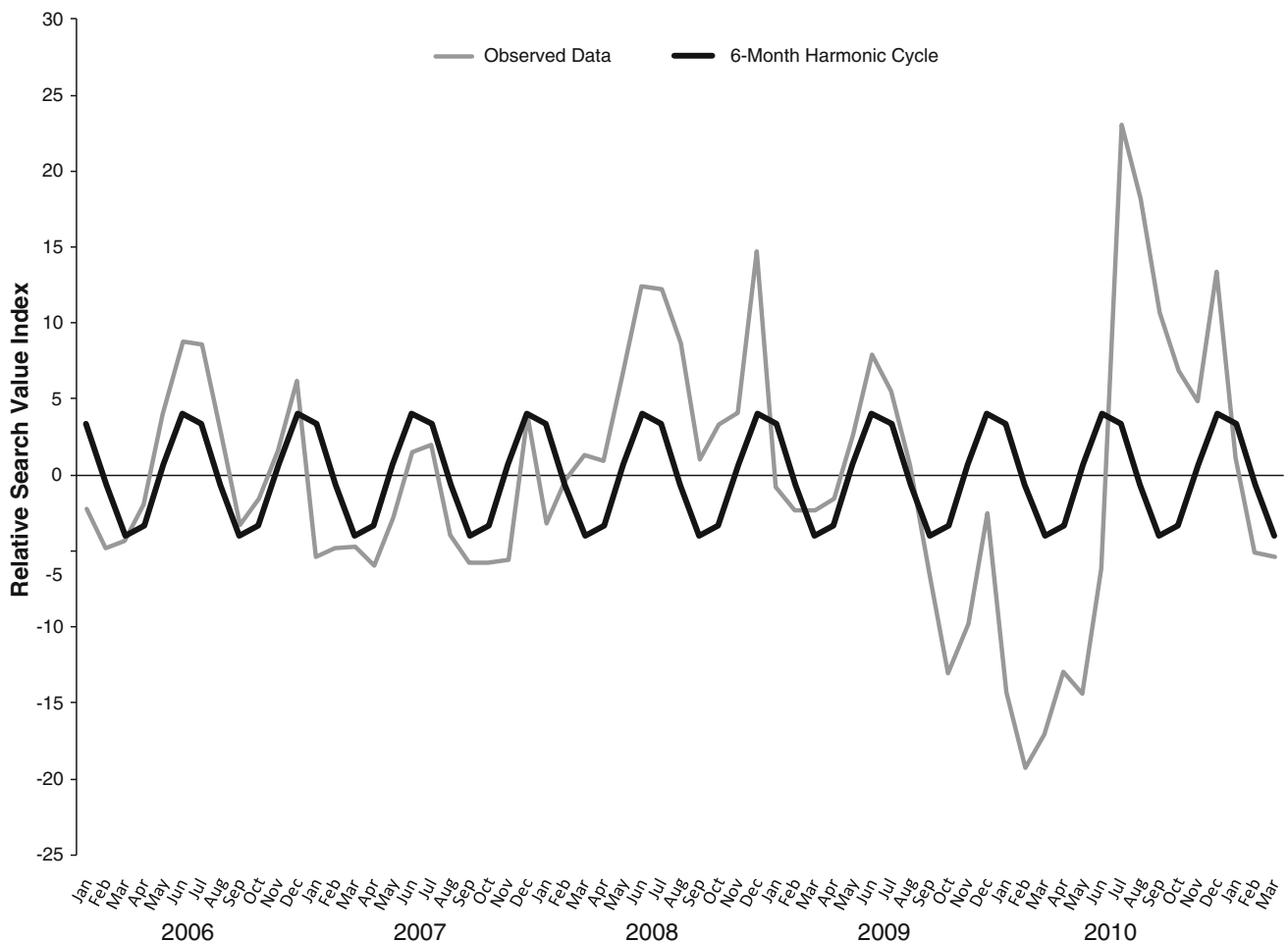
Fig. 1 Pornography time series (*gray line*) with a 6-month harmonic cycle (*black line*) superimposed

As seen in Table 1, a 6 month cycle accounted for 16 % of the variance in pornography searches, 24 % of the variance in prostitution searches, and 21 % of the variance in mate-seeking searchers (multiple Rs = .40, .49, and .46, respectively). It is worth nothing that, on average, a 6 month cycle only accounted for 2 % of the variance in the control key word searchers (M multiple R = .14). Taken together, these results indicate that searches for pornography, prostitution, and mate-seeking can be explained by a 6-month cycle. However, searches for control keywords (i.e., pets, popular websites, and car parts) did not exhibit a 6 month cycle. Figures 1, 2, and 3 display the 6-month harmonic cycles yielded from pornography, prostitution, and mate-seeking searches. Consistent with the predictions, searchers for prostitution and mate-seeking increased 2.78 and 5.67 % above the mean during January and July. Similarly, searches for pornography increased 4.28 % above the mean during December and June. Because none of the control keyword searches produced amplitudes greater than 1, it was not possible to compute peak locations for these search terms based on a 6-month harmonic cycle.

Discussion

This study extended past research examining the seasonal variation of sexual activity in the United States by investigating the seasonal changes in internet keyword searches related to sex and mating behaviors. As expected, we found that searches for keywords related to pornography, prostitution, and mate-seeking could be explained by a 6-month cycle. Additionally, as expected, this bi-seasonal trend tended to show peaks in the winter months (December and January) and during the early summer (June and July). By examining changes in the public's interest in sex and mating behaviors in real time, the current research complemented and extended previous research which has tended to infer these seasonal changes via various outcomes that occur months after coitus occurs (e.g., birth records, STI rates, abortion rates, etc.).

The replication of a biseasonal trend of keyword searches related to sex and mating behaviors is further evidence suggesting that the sexual activity of individuals residing in the United States can be partially predicted from the time of the year. Such findings
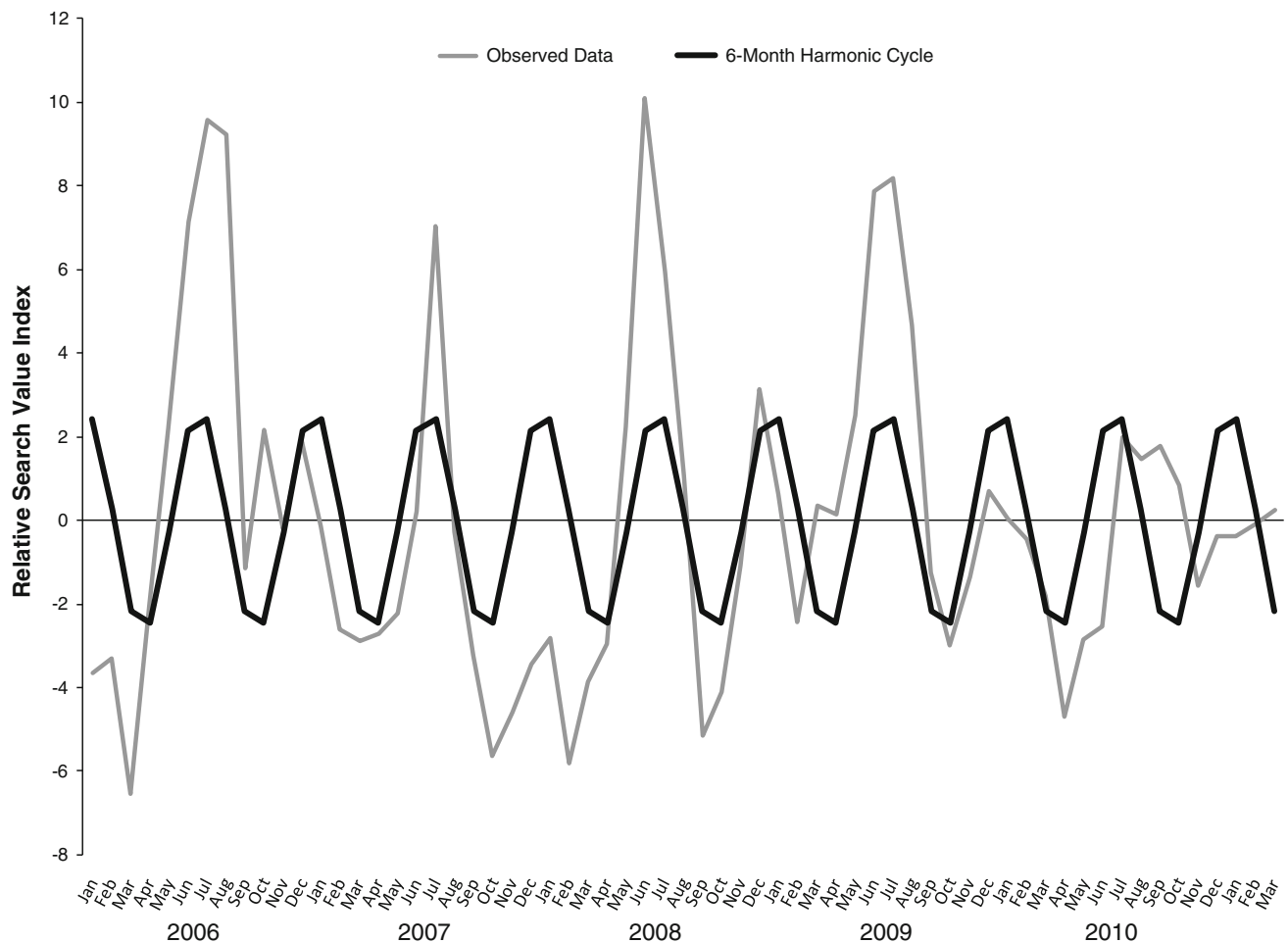
Fig. 2 Prostitution time series (*gray line*) with a 6-month harmonic cycle (*black line*) superimposed

suggest that explanations for a 6-month seasonal cycle in sexual behavior which only focus on explicit motives (e.g., tax laws, preferred season of birth etc.) and ignore implicit motives (e.g., seasonal hormonal changes) are insufficient (see Macdowall et al., 2008). Additionally, because the trends for pornography (a proxy measurement of sexual drive), prostitution, and mate-seeking searches produced almost identical trends, it is likely that these findings reflect a general trend in sexual desire and activity and not a trend specific to a given keyword category.

Although the results of the current study occurred in a manner predicted by previous research, there were several limitations that should be noted. Other than location, Google Trends does not supply user data, such as gender. Therefore, it is unknown if the biseasonal trend found for sex and mating behaviors is the same for men and women. Given that men tend to be the primary consumers of pornography and are more likely to seek out prostitutes than women (Baumeister et al., 2001), it is likely that the trends found for those keywords can be attributed to men. However, because both men and women are equally likely to utilize dating websites (Fallows, 2005), it is less clear whether or not this trend occurred due to changes in the keyword searches of men, women, or both. Of

course, given that sex is an interpersonal activity, it is likely that for most heterosexual men any increase in their sexual activity implies an increase in women's sexual activity.

An additional limitation of the current study was that Google Trends does not provide the raw number of times a term was searched for in a given month. Such information would be useful in order to better understand exactly the size of seasonal trends found in the current study. However, given the number of internet searches done each month using Google, especially for pornography and online dating sites (Ropelato, 2006), it seems likely that even a small change in RSVI in a given month could reflect thousands of additional searches. Therefore, the modest amplitudes found in the current study (*M* amplitude = 4.24 %) likely reflect thousands (even millions) of additional searches that occur seasonally during the winter and early summer for sex and mating behaviors.

The current study employed a fairly novel methodology, Google keyword searches, to examine the seasonal trend in the public's interest in sex and mating behaviors. Given the prevalence of internet use, this methodology allows for a large-scale sampling of various topics that people might be thinking about and interested in examining during a given time period. Additionally, this
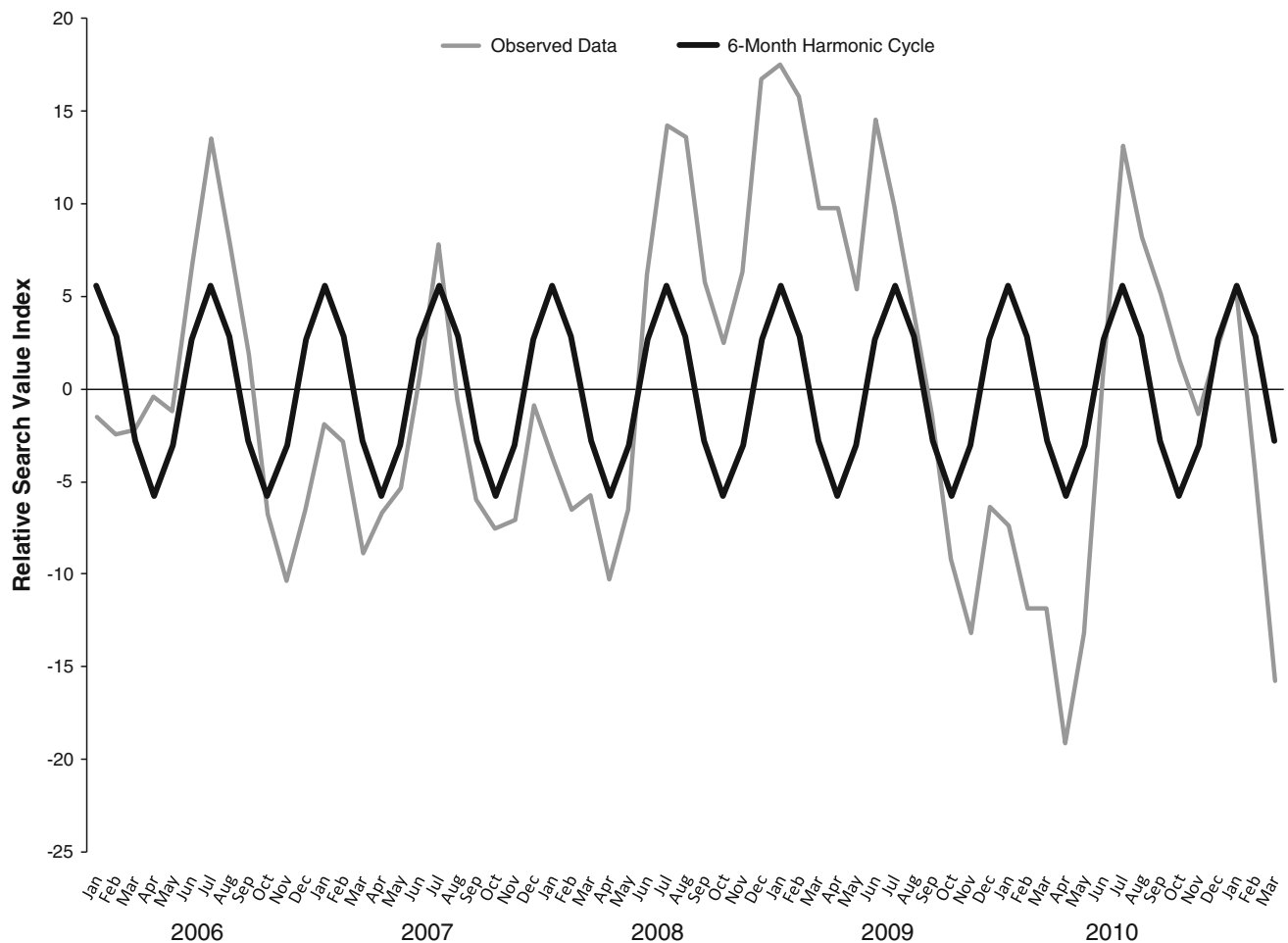
Fig. 3 Mate-seeking time series (*gray line*) with a 6-month harmonic cycle (*black line*) superimposed

Table 1 Harmonic analysis fitting 6-month cycles to the Relative Search Value Indices of pornography, prostitution, mate-seeking, and control terms

Search terms	Multiple *R*	% Variance explained	Amplitude	Peak locations
Pornography	.40	16**	4.28 %	December, June
Prostitution	.49	24**	2.78 %	January, July
Mate-seeking	.46	21**	5.67 %	January, July
Control: pets	.12	1	0 %	n/a
Control: popular websites	.11	1	0 %	n/a
Control: car parts	.19	4	0 %	n/a

Note. All analyses were based on 63 monthly observations from January 2006 to March 2011

** *p* < .01

methodology affords a convenient and inexpensive means of assessing topics that might be too sensitive (e.g., prostitution, pornography, etc.) and difficult to measure via traditional self-report methodologies (Tourangeau & Yan, 2007). With the enormous amount of information provided by internet search engines, future researchers might be able to examine the occurrence of various trends in order to further understand a variety of human behaviors, including the omnipresent interest in obtaining romantic and sex partners.

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