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Predicting Fluctuations in Widespread Interest: Memory Decay and Goal-Related Memory Accessibility in Internet Search Trends

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Memory and interest respond in similar ways to people's shifting needs and motivations. We therefore tested whether memory and interest might produce similar, observable patterns in people's responses over time. Specifically, the present studies examined whether fluctuations in widespread interest (as measured by Internet search trends) resemble two well-established memory patterns: memory decay and goal-related memory accessibility. We examined national and international events (e.g., Nobel Prize selections, holidays) that produced spikes in widespread interest in certain people and foods. When the events that triggered widespread interest were incidental (e.g., the death of a celebrity), widespread interest conformed to memory decay patterns: It rose quickly, fell slowly according to a power function, and was higher after the event than before it. When the events that triggered widespread interest were goal related (e.g., political elections), widespread interest conformed to patterns of goal-related memory accessibility: It rose slowly, fell quickly according to a sigmoid function, and was lower after the event than before it. Fluctuations in widespread interest over time are thus similar to standard memory patterns observed at the individual level due perhaps to common mechanisms and functions.

Keywords: interest, memory, goal pursuit

Widespread interest rises and falls in seemingly unpredictable ways. Entire nations will fixate for long durations on a fad or trend. At other times, they will decide suddenly that a fad is outdated or that a new idea is better than a current one. Widespread shifts in focus have consequential outcomes. They can determine whether economic markets are created or destroyed or whether political leaders are elected or deposed. An understanding of the patterns by which widespread interest swells and subsides can therefore shed light on important societal outcomes.

In the present work, we tested whether widespread interest fluctuates according to the same principles that determine attention and memory at the individual level. Specifically, we examined whether widespread interest—in the form of Internet search trends—conforms to two well-established memory patterns: memory decay, which is the standard forgetting pattern that is observed when an individual processes information (Ebbinghaus, 1885; Wixted & Ebbesen, 1991), and goal-related memory accessibility, which is the typical memory pattern that accompanies and facilitates goal pursuit (Förster, Liberman, & Higgins, 2005). Numerous comparisons have revealed memory patterns to be similar at the individual and aggregate levels (e.g., Wixted & Ebbesen, 1997), but those comparisons have focused on small aggregates measured in laboratory settings or on computer simulations (R. B. Anderson, 2001). The question therefore remains whether memory patterns observed at the individual level can emerge in real-world data at much larger scales—among national and international populations. Furthermore, although some work has drawn parallels between memory performance and interest (e.g., DeWall, Maner, Deckman, & Rouby, 2011; Fitzsimons & Shah, 2008; Maner, Miller, Rouby, & Gailliot, 2009), no research has tested whether highly specific patterns (e.g., rates of change) are common between memory and widespread interest. In the present work, we tested these possibilities directly. We examined whether memory decay and goal-related memory accessibility patterns are apparent in national and international Internet search trends over time.

Memory Decay Versus Goal-Related Memory Accessibility

We examined two well-established patterns of memory in the present work: memory decay (MD) and goal-related memory accessibility (GRMA). MD describes the fading of memory over time. Memory for an event tends to decrease over time according to a power function, so that the rate of forgetting is initially large but decreases continuously (Klatzky, 1980; Wixted & Ebbesen, 1991). Furthermore, because the rate of forgetting slows, a memory is usually not entirely lost. Some portion of it is retained long term (Wixted & Ebbesen, 1997).

Memory does not always decay according to a power function, however. Memory for some information is sustained to support ongoing goals and motives (e.g., Zeigarnik, 1927). GRMA describes the tendency for individuals to remember information relevant to their goals. Much like MD, GRMA follows a standard

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pattern. When in pursuit of a goal, the accessibility of goal-relevant information in memory increases as goal attainment draws near, peaks when the goal is attained, and is inhibited following fulfillment, thereby freeing mental resources for other pursuits (Förster et al., 2005).

MD and GRMA are observed at different times. MD is observed for information that is relatively incidental. A person encounters new information in the environment, and memory for it tends to decay over time. In contrast, when the information is central to some ongoing goal or motive, it will be maintained in memory as needed for optimal goal management.

Although the two memory patterns differ in form and in terms of the contexts in which they arise, both can be seen as consistent with a type of need-based conceptualization of memory. A strict need-based view of memory was proposed by J. R. Anderson and Schooler (1991). They posited that the probability of a person remembering some information is proportional to the likelihood that the person will need to recall the information to interact optimally with the environment. Research in support of this view has demonstrated that memory for information is highly correlated with the likelihood of encountering the information in the environment (J. R. Anderson & Schooler, 1991). Such correspondence was demonstrated specifically for MD: People's memory for information decreased over time according to a power function (i.e., people's memory decayed), and, at the same time, the likelihood of encountering that information also decreased over time according to a power function.

GRMA fits a modified version of this need-based perspective. J. R. Anderson and Schooler (1991) did not discuss GRMA in their work, nor did they examine a need-based explanation for it. One might even interpret their need-based approach as insufficient to explain GRMA, because their strict need-based account describes memory for information as reflecting patterns of prior exposure to that information. It describes human memory as "in some sense making a statistical inference" about the likelihood of encountering that information in the future (p. 400). GRMA is inconsistent with that particular view because GRMA patterns demonstrate rapid inhibition of goal-related information in memory once a goal is fulfilled. This inhibition in memory occurs even though the frequencies of both prior exposure and ongoing exposure to goal-related information are high (Förster et al., 2005). A statistical inference ought to conclude that the goal-related information is highly likely to be encountered, and so memory for the information should persist. Yet memory in this case drops rapidly. GRMA does, however, reflect needs—a person has little need for holding goal-relevant information in mind once the goal is complete. And so a modification of the need-based explanation of memory could account for both MD and GRMA so long as both environmental variables (the likelihood of encountering the information in the environment) and motivational variables (whether a person needs to process the information to meet ongoing goals) are considered to determine one's needs. In the present work, we tested whether these two memory phenomena, which both fit into a loose need-based account, could be observed among large aggregates of people.

From Memory of Individuals to Interest of Large Populations

We tested whether MD and GRMA patterns occur in measures of widespread interest. Such a correspondence raises at least two questions. First, why should individual-level patterns such as MD and GRMA be observed at the aggregate level? And second, why should the time course for memory correspond to the time course for interest? We address both questions below.

From Individuals to Large Populations

Despite the many changes that are introduced when moving from an assessment of individuals to that of large groups, individual- and group-level outcomes are often congruent. Indeed, not only are individual-level outcomes frequently preserved at the group level, but they are in some cases amplified and hence even more apparent. This is because aggregation reduces noise (Epstein & O'Brien, 1985), allowing underlying, component processes to surface. Moreover, interpersonal processes that are introduced at the aggregate level often preserve and sustain individual-level processes, as when contagion causes interpersonal sharing and hence the preservation of mental states (Hatfield, Cacioppo, & Rapson, 1994; Kelly & Barsade, 2001). Due to these various factors, a wide range of individual-level outcomes have been observed at the level of large groups (e.g., Ostroff, 1992; Schmitt, Colligan, & Fitzgerald, 1980; Steel & Ones, 2002).

To be sure, psychological outcomes at the individual level will not always be observed at the aggregate level (Katona, 1979; Robinson, 1950; Schelling, 1978). However, we expected to find a correspondence between the two levels based on the factors that have predicted incongruence in other work.

One reason for incongruence between individual-level outcomes and aggregate-level outcomes is cross-situational variance. If the outcome is one that varies significantly across individuals and contexts, then any individual-level outcomes tend to wash out in the aggregate (e.g., Robinson, 1950). However, MD and GRMA are relatively stable across individuals and contexts, and so their patterns are likely to carry over from the individual- to the group level. Indeed, MD is considered an intrinsic property of memory, the form of which has been shown to remain constant across types of memory tasks and across a range of animal species (Wixted & Ebbesen, 1991). The general form of MD is not affected by altering time spent encoding (e.g., Wixted & Ebbesen, 1991), time between encoding and testing (Klatzky, 1980), or motivations to remember (R. B. Anderson, Tweney, Rivardo, & Duncan, 1997). GRMA is likewise considered to be an inherent property of goals and motives. Förster, Liberman, and Friedman (2007) described numerous features of GRMA, citing support from studies on a variety of goals and across a range of contexts and animal species. Given the high reliability of both MD and GRMA patterns, we expected that they would persist at the group level.

Another reason for incongruence between the individual- and group levels is mathematical distortion. This specifically is a concern when observing power functions at the aggregate level, because functions at the individual level that do not conform to power curves may nevertheless appear to do so when averaged or summed together (R. B. Anderson, 2001). However, this type of distortion was not a concern for the present work because our aim was to distinguish MD-like curves, which already conform to power functions at the individual level (Klatzky, 1980; Wixted & Ebbesen, 1991), from GRMA-like curves, which we expected would not conform to a power function even at the aggregate level. We expected that GRMA curves would conform to linear or sigmoid functions, as discussed later. Thus, although mathematical distortions do occur in some cases, we did not expect them to affect the present investigation.

From Memory to Interest

We suspected also that patterns of memory over time would be highly congruent with patterns of interest over time. This expectation is based largely on functionalist views of the mind, such as the need-based theory of memory. The strict need-based theory (J. R. Anderson & Schooler, 1991) posits that human memory functions as needed to enable optimal interactions with the environment. Thus, memory for an idea decays over time because the probability of encountering it also decays. As mentioned previously, we used a more inclusive version of this theory by contending that need-based memory ought to incorporate not only environmental concerns but also ongoing goals and motives. Thus, in our view, memory considers needs that are both external (shifts in the environment) and internal (shifting goals and motives). Consistent with that view, ample research suggests that memory performance is as sensitive to internal needs as to external ones (e.g., Förster et al., 2007).

We contend that memory serves much the same purpose as interest—to facilitate adaptive behaviors based on changing needs—and so the two should follow many of the same patterns. Indeed, interest serves ultimately to guide and plan action (e.g., Ajzen, 2001), and memory theorists who take a functionalist perspective have argued that memory serves the same purpose (Glenberg, 1997; Schacter, Addis, & Buckner, 2007). If both interest and memory serve ultimately to facilitate certain types of actions, then both memory and interest should fluctuate concordantly with shifting needs to act.

There is ample empirical evidence that memory and interest respond in similar ways to shifting needs. When in pursuit of a goal, people have heightened memory for goal-relevant information (Förster et al., 2005), and they express heightened (yet automatic and unconscious) interest in goal-relevant objects and people (Ferguson & Bargh, 2004; Fitzsimons & Shah, 2008). Furthermore, both memory for and interest in goal-relevant objects are inhibited when sufficient progress has been made toward one's goals. Meeting the demands of a goal decreases memory for goal-related information (Förster et al., 2005) and decreases interest in people and objects that are instrumental to the goal (Fitzsimons & Fishbach, 2010; Fishbach & Dhar, 2005). Indeed, memory and interest patterns are so frequently similar that researchers who wish to demonstrate cognitive tuning to goals often point to changes in both memory and interest to make their case (e.g., DeWall et al., 2011; Fitzsimons & Shah, 2008; Maner et al., 2009).

Prior work suggests that memory and interest respond in similar ways to people's shifting needs. Due to the psychological mechanisms that memory and interest seem to share, we made the prediction that memory and interest might produce similar, observable patterns in people's responses over time. Specifically, we hypothesized that two ostensibly disparate phenomena—individual-level memory and interest among large populations—would produce similar, highly specific patterns. We thus examined in the present work whether MD and GRMA can be observed in fluctuations in widespread interest.

The Present Research

We used Internet search trends to assess interest in two subjects: people and food. We targeted national and international events (e.g., political elections, holidays) that we expected would cause widespread interest in certain people and foods to spike (*triggering events*). Moreover, we assessed whether MD and GRMA could predict the pattern by which widespread interest rose and fell in response to those triggering events. Each triggering event caused widespread interest in some person or food to reach a peak level (*peak interest*). We examined numerous features related to peak interest (see Figure 1), which we describe below, to see whether they paralleled well-established memory patterns.

First, time course of people's interest in each subject was examined. This included the time point at which interest in each subject started to increase, leading ultimately to peak interest. And it included the time point at which interest in each subject seemed to level off after the triggering event occurred. This analysis allowed us to measure how long it took for widespread interest in each subject to peak

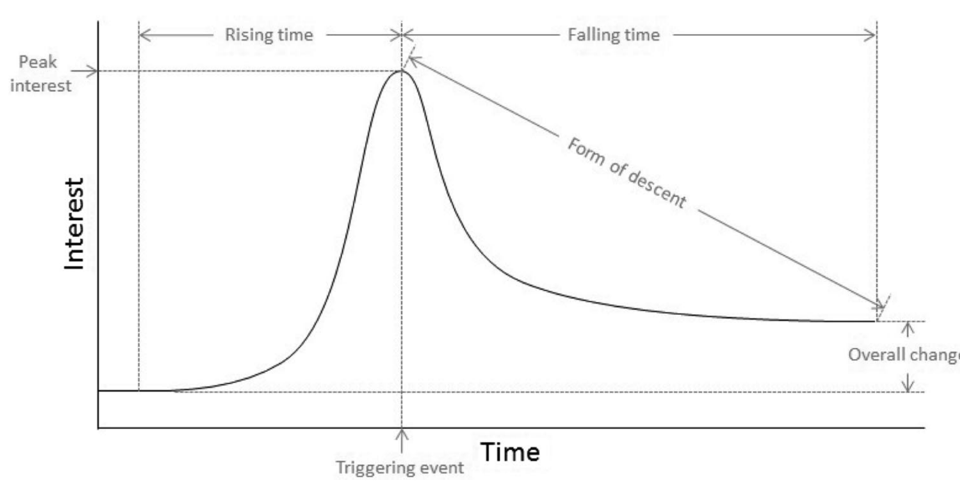

Figure 1. We examined instances in which widespread interest peaked due to some triggering event. This diagram shows the various features of each event that were examined in both studies.

in response to the triggering event (*rising time*) and how long it took for it to stabilize afterward (*falling time*).

Second, the *overall change* in interest that occurred due to the triggering event was measured. In each case, there was a relatively stable level of interest in the subject before any effects of the triggering event were observed, and there was a relatively stable level of interest in the subject long after the triggering event had passed. We measured the overall change in interest that occurred between those two time periods.

Third, we assessed the rate at which widespread interest fell in the aftermath of each triggering event (*form of descent*). Widespread interest after each triggering event was not sustained at peak levels but rather fell and eventually leveled off. We were interested in the form of that descent.

Predictions

We predicted that when the events that triggered widespread interest were incidental, interest levels over time would appear similar to MD. When the triggering events were goal related, we expected that interest levels would appear similar to GRMA. Moreover, we expected that rising time, falling time, overall change, and form of descent would all vary as a function of whether incidental triggers (which are linked to MD) or goal-related triggers (which are linked to GRMA) were driving widespread interest (see Table 1).

Memory decay. We expected that incidental events would trigger MD-like patterns of interest. We expected rising time to be short and falling time to be long, due to the slow decrease in interest. We also expected that overall change in interest would be positive, as evidence of long-term retention (Wixted & Ebbesen, 1997). In addition, we expected that the form of descent would be approximated best by a power function, as has been found in prior work on MD (e.g., Sikström, 1999; Wixted & Ebbesen, 1991). However, some have argued that MD more closely follows an exponential function (R. B. Anderson & Tweney, 1997). We therefore fitted both functions (power and exponential) to the descending curves in the present studies.

GRMA. We expected that goal-related events would trigger GRMA-like patterns of interest. We expected that rising time would be long, due to the anticipation of the triggering event, and that falling time would be short, due to the tendency for people to move on to other concerns once goals are completed. We also expected that overall change in interest would be negative, due to post-fulfillment inhibition (Förster et al., 2005). Finally, we anticipated that the form of descent would exhibit a relatively fast drop, which would not conform to a power or exponential function (as with MD) but perhaps to some other function. Though no prior work has examined the rate of post-fulfillment inhibition, we tested the fits of two curves: linear and sigmoid. A linear trend could capture an immediate drop in interest, should that be observed; a sigmoid function is useful for modeling *nearly* immediate drops in activation, and it has been incorporated into numerous neural network models to approximate patterns of inhibition (Hopfield, 1982, 1984). We expected that in the case of goal-related triggering events, interest might decrease according to either a linear or sigmoid function rather than to a power or exponential function.

Google Trends

We measured widespread interest using Google Trends, which monitors the frequency with which various terms are entered into the Google search engine over time. Google Trends gathers information daily, keeping track of where searches are conducted. This allowed us to measure interest in subjects at both the national and international levels. Google Trends computes a search volume index (SVI) for each search term. SVI scores represent the search frequency for the term on any given day relative to the search frequency of that term in January 2004.

Selection of Triggering Events

We had three aims when selecting triggering events to examine. First, we wanted to examine events that were salient and thus highly visible and culturally important. Second, we sought events that were common enough that many instances of each event could be assessed. Third, we wanted to compare incidental and goal-related events involving the same category of search terms (e.g., we wanted to avoid comparing incidental events that were linked to food with goal-related events that were linked to people because numerous, confounding variables could explain why widespread interest in food would differ from widespread interest in people).

Our selection of triggering events started with a pilot study for compiling a list of salient events. Twenty participants on Amazon Mechanical Turk (11 women; $M_{age} = 29.4$, $SD_{age} = 9.45$) listed examples that came quickly to mind of events that cause large populations to focus simultaneously (i.e., within a day) on a single thing (object, person, idea, etc.). Participants listed three events on average ($SD = 1.92$).

We wanted to draw two sets of comparisons from the list of events. The first comparison came from the two most frequently

Table 1
Main Predictions and Findings

	Predictions		Study 1: Food		Study 2: People		
Feature	Memory decay	Goal accessibility	Food recalls	Holidays	Deaths	Nobel prizes	Political elections
Rising time (days)	Short	Long	5.67 (4.18)$_a$	18.3 (9.57)$_b$	1.80 (1.03)$_a$	2.00 (1.12)$_a$	12.4 (6.02)$_b$
Falling time (days)	Long	Short	16.3 (8.17)$_a$	7.06 (4.22)$_b$	20.4 (11.3)$_a$	13.8 (4.15)$_a$	6.58 (4.14)$_b$
Overall change (SVI)	Positive	Negative	0.36 (0.79)$_a$	−0.12 (0.06)$_a$	2.95 (4.18)$_a$	1.42 (0.47)$_a$	−1.83 (2.09)$_b$
Form of descent	Power or exponential	Linear or sigmoid	Power (6 of 8)$_a$	Sigmoid (4 of 5)$_b$	Power (7 of 10)$_a$	Power (7 of 9)$_a$	Sigmoid (9 of 11)$_b$

Note. Means are displayed with standard deviations in parentheses. Values within the same study and row that have different subscripts are significantly different from one another ($p < .05$). SVI = search volume index.

listed events, political elections and celebrity deaths, which were both listed by 40% of respondents. Political elections seemed more goal related, because people usually seek to place a preferred politician in office, and celebrity deaths seemed more incidental, because people do not anticipate them. Moreover, both events were linked to an interest in people, allowing for a relatively even comparison. We also added Nobel Prize winners as an additional, incidental event that focused on people. Although no respondents in the pilot study listed Nobel Prize announcements as a common event, we included it due to its relatively high frequency and to account for event valence as explained in Study 2.

We selected holidays for a second comparison. We did this even though holidays was listed by only 10% of respondents. All events that were listed more frequently than holidays (natural disasters, sporting events, terrorist attacks, and crimes, which were listed by 35%, 35%, 25%, and 20% of respondents, respectively) could not be used because we could not find a suitable comparison or because there were too few instances of such events triggering national or international interest. Many holidays are linked to food in a rather goal-driven manner (i.e., people anticipate and look forward to eating holiday food), and so we selected another food-related event, food recalls, as a frequently occurring and relatively incidental comparison.

Google Trends was thus used in two studies to assess widespread interest over time. In Study 1, we examined interest in food (due to holiday food and food recalls), whereas in Study 2 we examined interest in people (due to celebrity deaths, Nobel Prizes, and political elections). We tested for evidence that MD and GRMA patterns can be used to predict fluctuations in widespread interest over time.

Study 1: Food Recalls and Holiday Favorites

In Study 1, we examined whether widespread interest in food exhibits patterns of MD and GRMA. We focused on two types of triggering events: food recalls and holidays. We expected that interest in recalled foods would conform to the standard pattern of MD, because people do not anticipate recalls and recalls do not culminate in widespread indulgence or fulfillment. In contrast, we expected that interest in holiday foods would exhibit patterns of GRMA, because people are motivated to consume them (and ultimately do).

Pilot Study

We conducted a pilot study to test whether food recalls are perceived more as incidental events, whereas the consumption of holiday food is goal related. We also assessed the perceived importance of both events. Sixty participants on Amazon Mechanical Turk (30 women; $M_{\text{age}} = 30.2$, $SD_{\text{age}} = 13.0$) were randomly assigned to indicate how they and people close to them view one of six events. Two of these events were food recalls and the consumption of holiday food. A third event was the completion of personal projects for school or work, which served as a prototypical goal against which to compare the consumption of holiday food. Three additional events that are irrelevant to the present study are described in Study 2.

Participants rated to what extent they agreed (1 = *Do not at all agree*; 7 = *Very much agree*) with nine randomly ordered statements regarding their assigned event. Agreement with three statements was averaged (Cronbach's $\alpha = .77$) to create an incidental event score. These statements described the event as one the participants or people close to them can predict (reverse scored), one they do not think much about until after it occurs, and one that they cannot influence or foresee. Agreement with three additional statements was averaged (Cronbach's $\alpha = .90$) to create a goal score. These statements described the event as one the participants or people close to them anticipate and prepare for, one they look forward to and are invested in, and one that satisfies a goal or desire that they have. Agreement with three final statements was averaged (Cronbach's $\alpha = .80$) to create an importance score. These statements described the event as important, one the participants or people close to them pay attention to, and one that interests them.

One-way analyses of variance (ANOVAs) predicting incidental event scores, goal scores, and importance scores as a function of the six conditions revealed significant variation in each variable (Fs > 2.44, ps $< .05$). Planned comparisons focused only on the three conditions relevant to Study 1. Table 2 displays the descriptive statistics and statistically significant differences. Results confirmed expectations. Food recalls were perceived as more incidental than the consumption of holiday food. In contrast, the consumption of holiday food was perceived as more goal related than were food recalls. Furthermore, the consumption of holiday food elicited similar perceptions as did the completion of a project for school or work. None of the three events was perceived as more important than the others.

The pilot data confirmed that food recalls and holidays are perceived in different ways, and we anticipated that such differences might lead to diverging effects on widespread interest. Food recalls may increase interest in a rather incidental manner, thereby eliciting MD patterns. Holidays may increase interest in a goal-related manner, thereby eliciting GRMA patterns. In the present study, we tested for evidence of such patterns.

Method and Results

Five foods that were each linked to a different holiday in the United States were examined. Nine recalled foods were taken from a recent news story (KCRA 3, 2010).[1] All foods along with the search terms used to analyze them are shown in Table 3.

Data for each food was gathered, with data from 5 or 6 years collected for each holiday. A single SVI distribution was computed for each holiday by averaging across calendar years (all Cronbach's αs $> .96$). Levels of peak interest did not differ across the two types of triggering events (recalls vs. holidays), $t(13) = 0.75$, $p = .46$. Hence, any observed differences could not be attributed to one type of triggering event eliciting higher overall interest than the other. Table 1 displays descriptive statistics for the analyses reported below.

Time course. For each food, peak interest was bordered by an ascending curve to the left and a descending curve to the right. *Rising time* was defined as the period between the start of the

[1] Two of the listed foods were excluded from the analysis. The 2006 Cadbury chocolate recall was excluded due to insufficient data. The 2008 Chinese dairy recall was excluded due to no apparent spike in SVIs during the recall.

Table 2
Pilot Study Results for Study 1

Event	Score		
	Incidental event	Goal	Importance
Food recalls	5.70 (0.84)$_a$	1.67 (0.60)$_a$	5.56 (1.71)$_a$
Consumption of holiday food	2.00 (1.54)$_b$	6.10 (0.72)$_b$	6.00 (0.72)$_a$
Completion of personal projects	2.53 (1.07)$_b$	5.25 (0.78)$_b$	5.03 (1.40)$_a$

Note. Means are displayed with standard deviations in parentheses. Different subscripts within a column denote values that differ significantly ($p < .05$).

ascending curve and peak interest. *Falling time* was defined as the period between peak interest and the end of the descending curve.

The start of the ascending curve and the end of the descending curve were determined with an algorithm that accounted for weekly fluctuations in SVIs. Weekly fluctuations (e.g., the tendency for *candy* searches to be higher during the weekend than during the week) made it so that SVIs would often increase (or decrease) from one day to the next even though the overall trend was for SVIs to be rising (or falling). Therefore, weekly SVI scores were calculated for each 7-day period before and after the day of peak interest. Thus, the SVI for the first day after peak interest was averaged with the SVIs for each of the 6 days after it. Likewise, the SVI for the second day after peak interest was averaged with the SVIs for the 6 days after it and so forth. To determine the start of the ascending curve, we started at the day of peak interest and moved backward in time until encountering a weekly SVI score that was equal to or less than the one occurring before it in time. The last day (i.e., that occurring latest in time) in that 7-day period was defined as the start of the ascending curve. To determine the end of the descending curve, we started at the day of peak interest and moved forward in time until encountering a weekly SVI score that was equal to or less than the one occurring after it in time. The first day (i.e., that occurring earliest in time) in that 7-day period was defined as the end of the descending curve. Thus, the ascending curve started where weekly SVI scores started to rise, and the descending curve ended where weekly SVI scores ceased to fall.

Rising time was defined as the number of days between the start of the ascending curve and peak interest. Falling time was defined as the number of days between peak interest and the end of the descending curve. Consistent with our predictions, rising time was significantly longer for holiday foods than for recalled foods, $F(1, 13) = 12.1$, $p = .005$, $\eta_p^2 = .50$, and falling time was significantly shorter for holiday foods than for recalled foods, $F(1, 13) = 5.48$, $p = .037$, $\eta_p^2 = .31$.

Repeated measures ANOVAs compared rising time with falling time within each triggering event. Interest in recalled foods was faster to rise than to fall, $F(1, 8) = 11.3$, $p = .010$, $\eta_p^2 = .59$, whereas interest in holiday foods was faster to fall than to rise, $F(1, 4) = 6.43$, $p = .064$, $\eta_p^2 = .62$.

Overall change. Overall change in SVIs due to each triggering event was also examined. Interest before each triggering event was computed as the average daily SVI for the week before the rising time period, and interest after each triggering event was computed as the average daily SVI for the week following the falling time period. Overall change was computed by subtracting interest before each triggering event from interest after it.

Overall change for the recalled foods was positive (and thus in the predicted direction) but not significantly different from zero, $t(8) = 1.37$, $p = .21$. Overall change for the holiday foods was negative and was significantly different from zero, $t(4) = 4.55$, $p = .010$, $d = 4.55$, suggesting post-fulfillment inhibition.

Form of descent. We examined the types of curves that most frequently offered the best fit across the two types of triggering events. We fitted four functions to the descending curves for each food: exponential, linear, power, and sigmoid. Each function contained two parameters (as those described by Rubin & Wenzel, 1996). Exponential functions were defined by the equation $y = ae^{bt}$, linear functions by $y = a + bt$, power functions by $y = at^b$, and sigmoid functions by $y = e^{a + (b/t)}$, such that y was widespread interested (in SVI scores), t was time (in days), and a and b were constants.

The number of curves that each function predicted best across the two types of triggering events (recalls vs. holidays) was entered into a chi-square analysis. The results revealed significant variation in fit across the two types of triggering events, $\chi^2(2) = 6.00$, $p = .05$. For food recalls, form of descent for six out of eight foods (75%) was best explained by a power function ($M_{R\text{-}squared} = .85$, $SD = .13$ across the eight foods), thus resembling the standard form of MD. For holidays, four out of five descending curves (80%) were best fit by a sigmoid function ($M_{R\text{-}squared} = .87$, $SD = .04$ across all five foods).

Power functions and sigmoid functions also fit the food recall curves and the holiday curves, respectively, above chance levels. For every food recall, a power function yielded significant fit (all R^2s $> .62$, ps $< .001$), and for every holiday food, a sigmoid function yielded significant fit (all R^2s $> .83$, ps $< .001$). Composite curves representing the two types of triggering events are compared in Figure 2.

Discussion

The results suggest that widespread interest in food rises and falls according to two well-established patterns of memory. For foods that garnered widespread interest due to food recalls, interest levels resembled MD in numerous ways: It rose quickly, fell slowly, and decreased according to a power function. In contrast,

Table 3
Foods Examined in Study 1

Holiday food	Recalled food
Christmas *candy* (2004–2009)	*Spinach* (2006)
Easter *ham* (2004–2010)	Peter Pan and Great Value *peanut butter* (2007)
Halloween *candy* (2004–2009)	Peanut Corporation of America *peanut butter* (2009)
Thanksgiving *turkey* (2004–2009)	Westland/Hallmark *beef* (2008)
Valentine's Day *candy* (2004–2010)	*Eggs* (2010)
	Gerber oatmeal rice and organic cereals (2007)
	Nestle cookies (2009)
	Topps Meat Company beef (2007)

Note. Search terms are in italics. Brand names were used when type of food did not yield a spike in search volume indices.

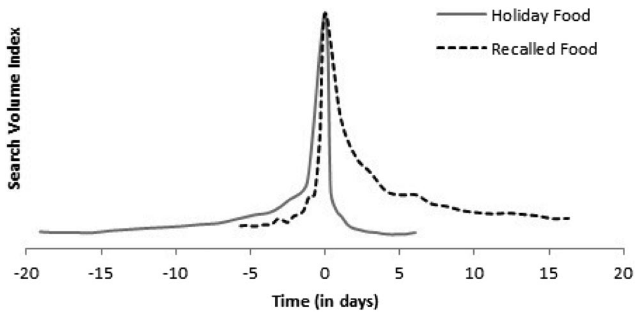

Figure 2. Representative curves are shown for each group of foods. The two curves were created by normalizing the time scales for each food. (The curve for each food was compressed or expanded so that the rising and falling times would match the means for its group.) Search volume indices were then summed within each group, and the two resulting curves were standardized so that their peaks would be equal.

for foods that people were looking forward to eating (i.e., holiday food), widespread interest resembled GRMA: It rose gradually, fell quickly following indulgence, and dropped below prepeak levels in a manner resembling post-fulfillment inhibition.

Descending interest in holiday food did not conform to a power function, suggesting a different process than that observed for recalled foods. Interest in holiday food seemed to drop according to a sigmoid curve. Post-fulfillment inhibition thus appears to follow the same function as that used to model inhibition in neural networks (e.g., Hopfield, 1984).

Alternative explanations. Although the data suggest that widespread interest fluctuates similarly to well-established memory patterns, two alternative explanations could be offered. First, search trends may have reflected practical concerns. SVIs for recalled foods may have decreased slowly due to people monitoring the news in order to keep apprised of developments. SVIs for the holiday foods may have fell quickly because people had leftovers and therefore did not need to actively seek more. Second, the observed patterns of interest could have been driven by valence rather than by the incidental or goal-related aspects of the triggering events. The negative emotions associated with recalled foods may have caused those foods to persist longer in people's minds relative to holiday foods (e.g., Ochsner, 2000). Both explanations could account for some of the observed results, but neither can account for all of them (e.g., the precise form of MD, the slow rise of GRMA followed by post-fulfillment inhibition). The most parsimonious explanation seems to be that the patterns represented processes similar to those that drive MD and GRMA. Nevertheless, in Study 2 we tested for clearer evidence to rule out these explanations.

Study 2: Nobel Laureates, Deceased Celebrities, and Politicians

In Study 2, we examined interest in famous persons across three types of triggering events: receipt of Nobel Prizes, deaths, and winning of political elections. We expected that widespread interest in Nobel Prize winners and the deceased would fluctuate in accordance with MD patterns, because people usually do not anticipate Nobel Prize outcomes or deaths. In contrast, we expected that interest in political election winners would conform to GRMA, because people typically approach elections with the goal of voting a preferred politician into office.

Pilot Study

The pilot study described in Study 1 served also as a pilot study for Study 2. Three events in addition to those described in Study 1 were rated by participants: awarding of Nobel Prizes, celebrity deaths, and the election of politicians to public office. Incidental event scores, goal scores, and importance scores were computed for each event, and these scores were compared against each other as well as with scores for the completion of personal projects for school or work (see Table 4 for descriptive statistics and statistically significant differences). As expected, both awarding of Nobel Prizes and celebrity deaths were rated as more incidental in nature than were the election of politicians and completion of personal projects. In contrast, election of politicians and completion of personal projects were rated as more goal related than were the awarding of Nobel Prizes and celebrity deaths. Furthermore, none of the four events was rated as more important than the others.

We predicted MD patterns due to the incidental events (winning of Nobel Prizes and celebrity deaths) and a GRMA pattern due to the goal-related event (winning a political election). Furthermore, in Study 2, our predictions diverged from those offered by a practicality explanation. We predicted that interest due to political elections would be quickly inhibited, even though it is arguably more practical to attend to elected officials than to Nobel laureates or the deceased. We also expected that interest due to Nobel Prizes and deaths alike would persist over time, even though Nobel prizes are generally positive and deaths are negative, thus ruling out a valence-based explanation.

Method and Results

Politicians were 12 winners of United States senatorial or gubernatorial races in 2010 who generated observable SVI data at the national level. Nobel laureates were nine recipients of the Nobel Prize from 2005 to 2010 who generated observable data at the international level. Deceased celebrities were taken from a list of notable deaths in 2009 (Rowe, 2009). Table 5 lists the people within each type of triggering event who were examined. As in Study 1, there was no difference in levels of peak interest between the triggering events expected to produce MD (Nobel Prizes and deaths) and the triggering events expected to produce GRMA

Table 4
Pilot Study Results for Study 2

	Score		
Event	Incidental event	Goal	Importance
Awarding of Nobel Prizes	5.30 (1.27)$_a$	2.77 (1.56)$_a$	3.87 (1.72)$_a$
Celebrity deaths	4.87 (0.98)$_a$	1.90 (0.93)$_a$	4.93 (1.60)$_a$
Election of politicians	3.15 (0.63)$_b$	4.26 (1.37)$_b$	5.00 (1.31)$_a$
Completion of personal projects	2.53 (1.07)$_b$	5.25 (0.78)$_c$	5.03 (1.40)$_a$

Note. Means are displayed with standard deviations in parentheses. Different subscripts within a column denote values that differ significantly ($p < .05$).

Table 5
Persons Examined in Study 2

Politicians	Nobel laureates	Deceased celebrities
Andrew Cuomo	Al Gore	Billy Mays
Barbara Boxer	Barack Obama	Brittany Murphy
Harry Reid	Doris Lessing	Chris Henry
Jerry Brown	Harold Pinter	David Carradine
John McCain	John Hall	Ed McMahon
Marco Rubio	Liu Xiabo	Farrah Fawcett
Mike Lee	Mario Vargas Llosa	Michael Jackson
Patty Murray	Orhan Pamuk	Patrick Swayze
Rand Paul	Paul Krugman	Ted Kennedy
Rick Scott		Walter Cronkite
Ron Johnson		
Scott Walker		

(political elections), $t(29) = 1.40$, $p = .17$. All measures were obtained and analyzed in the same manner as in Study 1. Descriptive statistics for the analyses reported below are displayed in Table 1.

Time course. Consistent with predictions, rising time for political elections was longer than for Nobel Prizes, $F(1, 28) = 41.1$, $p < .001$, $\eta_p^2 = .60$, and deaths, $F(1, 28) = 37.3$, $p < .001$, $\eta_p^2 = .57$. Furthermore, falling time for political elections was shorter than for Nobel Prizes, $F(1, 28) = 19.8$, $p < .001$, $\eta_p^2 = .41$, and deaths, $F(1, 28) = 5.05$, $p = .033$, $\eta_p^2 = .15$. Differences in rising time and falling time between Nobel Prizes and deaths were not significant (Fs < 4.00, ps $> .05$).

Further analyses compared rising time and falling time within each triggering event. A repeated measures ANOVA revealed that rising time was longer than falling time for political elections, $F(1, 11) = 9.60$, $p = .010$, $\eta_p^2 = .41$. In contrast, rising time was shorter than falling time for Nobel Prizes, $F(1, 8) = 67.7$, $p < .001$, $\eta_p^2 = .89$, and deaths, $F(1, 9) = 29.0$, $p < .001$, $\eta_p^2 = .76$.

Overall change. Consistent with long-term retention, overall change due to Nobel Prizes was significantly greater than zero, $t(8) = 2.86$, $p = .021$, $d = 2.02$, as was overall change due to deaths, $t(9) = 2.23$, $p = .053$, $d = 1.49$. In contrast, overall change due to political elections was significantly less than zero, $t(11) = -3.04$, $p = .011$, $d = 1.83$, which is consistent with post-fulfillment inhibition.

A one-way ANOVA revealed that overall change varied significantly across the three triggering events, $F(2, 30) = 8.29$, $p = .001$, $\eta_p^2 = .37$. Comparisons revealed that overall change due to elections was less than those due to Nobel Prizes, $F(1, 28) = 15.8$, $p < .001$, $\eta_p^2 = .36$, and deaths, $F(1, 28) = 6.61$, $p = .016$, $\eta_p^2 = .19$. Overall change due to Nobel Prizes and deaths did not differ ($F < 1.60$, $p > .22$).

Form of descent. A chi-square revealed significant variation in the proportions of best fit across the three types of triggering events, $\chi^2(4) = 20.4$, $p < .001$. For political elections, nine of 11 curves (81.8%) were fit best by a sigmoid function ($M_{R\text{-}squared} = .91$, $SD = .09$ across the 11 politicians). This was a significantly different outcome from that seen for Nobel Prizes, $\chi^2(2) = 7.10$, $p = .008$, where seven out of nine curves (77.8%) were best fit by a power function ($M_{R\text{-}squared} = .93$, $SD = .05$ across the nine laureates), and from that seen for deaths, $\chi^2(2) = 14.8$, $p = .001$, where seven out of the 10 curves (70.0%) were best fit by a power function ($M_{R\text{-}squared} = .92$, $SD = .06$ across the 10 celebrities).

The power and sigmoid functions also fit the descending curves above chance levels. Power functions yielded significant fit for every celebrity death (all R^2s $> .81$, ps $< .001$) and for every Nobel Prize (all R^2s $> .83$, ps $< .001$), whereas sigmoid functions yielded significant fit for every political election (all R^2s $> .74$, ps $< .05$). Composite curves representing the three triggering events are compared in Figure 3.

Discussion

Study 2 provided converging evidence that widespread interest conforms to patterns of MD and GRMA. Widespread interest due to Nobel Prizes and deaths was highly consistent with MD patterns: It rose quickly, fell slowly according to a power function, and showed long-term retention, so that people were more interested after peak interest than before it. Interest due to political elections, in contrast, was highly consistent with GRMA: It rose slowly as the election approached, fell sharply after it, and was much lower after elections than it was before them, consistent with post-fulfillment inhibition. The pattern of inhibition following political elections tended to conform to a sigmoid function, as it did for holiday food in the previous study. Study 2 therefore replicated the findings from Study 1, albeit with people rather than food.

General Discussion

Widespread, collective interest among national and international populations appears to produce the same patterns over time as those observed in individual-level memory. Laboratory experiments have revealed predictable patterns by which memory changes over time. The standard pattern of memory (MD) dictates that memory for information decays slowly over time with some long-term retention. Another pattern of memory (GRMA) dictates that when a person is in active pursuit of a goal, memory for goal-related information increases slowly as one approaches fulfillment and is quickly inhibited following attainment. The present work revealed that widespread interest follows similar patterns. The present hypothesis was based on previous work demonstrating that memory and interest share underlying mechanisms—both

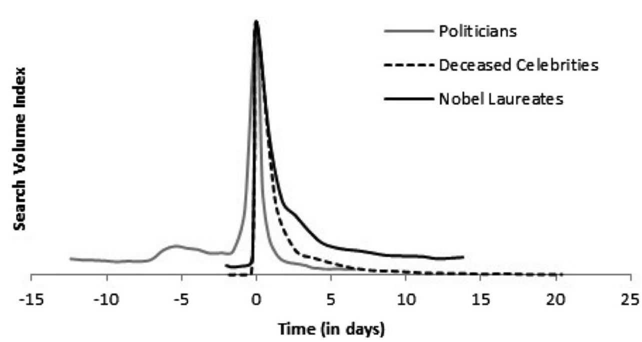

Figure 3. Representative curves are shown for each group of people. The three curves were created by normalizing the time scales for each person. (The curve for each person was compressed or expanded so that the rising and falling times would match the means for its group.) Search volume indices were then summed within each group, and the three resulting curves were standardized so that their peaks would be equal.

respond to individuals' shifting needs in similar ways (e.g., DeWall et al., 2011; Fitzsimons & Shah, 2008; Maner et al., 2009). Thus, we do not consider the shared forms that we observed in the present work to be mere coincidence but rather to be a product of shared, underlying mechanisms between individual-level memory and widespread interest.

Whether widespread interest will conform to MD or GRMA depends on how the interest is triggered. Numerous events can propel a person or idea into the spotlight. The present results revealed that when such events are relatively incidental (e.g., when a famous person dies), interest will rise and fall according to patterns of MD. When such events are linked to collective goals (e.g., when a nation is electing a political leader), interest will reflect patterns of GRMA. Each pattern predicts numerous variables, including how quickly interest will rise, how slowly it will fall, and what the overall change in interest will be in the aftermath of the event. The subtle psychological features of an event can therefore determine how large populations will regard it over time.

Implications and Future Directions

The present data demonstrate that patterns observed in memory at the individual level are also observed in the search patterns of large groups. Individual-level patterns often wash out when assessed at the aggregate level, particularly if the patterns under investigation vary dramatically across individuals or contexts (e.g., Robinson, 1950). However, the phenomena observed in the present article (MD and GRMA) generalized across that shift in scale, suggesting that they are relatively unchanged by contextual variations and by the introduction of interpersonal (i.e., social and cultural) factors. This finding is consistent with prior views of MD and GRMA as rather prevalent and robust phenomena (Förster et al., 2007; Wixted & Ebbesen, 1991).

The observed results also suggest a correspondence between memory and interest. Prior work has found memory to vary predictably as a function of need (J. R. Anderson & Schooler, 1991; Förster et al., 2005), and we found that interest varied in a similar manner. This convergence fits functionalist views of the mind that have emphasized, as William James (1890) originally did, that thinking is for doing (see also Fiske, 1992; Lewin, 1926). Functional perspectives of memory in particular have argued that memory serves to promote adaptive action planning (Glenberg, 1997; Schacter & Addis, 2007) as a function of needs and goals (e.g., J. R. Anderson & Schooler, 1991; Förster et al., 2007). If all thinking is for doing, then interest may serve many of the same aims that memory does—the two processes may fluctuate concordantly to facilitate and inhibit certain types of behaviors. Thus, memory and interest (and perhaps other mental functions that prepare one for action) may respond in similar ways to shifting needs and goals. The present results are consistent with such a view.

Future work may examine whether other patterns are common across memory and interest (and other cognitive processes) due to common responses to shifting needs. We found that two well-established memory patterns were quite applicable to widespread interest. Other memory phenomena may apply to interest, and vice versa. In addition, future work may determine when this correspondence between memory and interest breaks down. Although numerous lines of work have treated memory and interest as serving goals and motives in similar ways (e.g., DeWall et al., 2011; Fitzsimons & Shah, 2008; Maner et al., 2009), recent research suggests that memory and interest can meaningfully differ if active goals require them to (Ackerman et al., 2009; U. S. Anderson et al., 2010).

Future work may also examine the interpersonal processes that help sustain or inhibit widespread interest in the manner observed in the present studies. Our measure of interest (Internet search trends) may have been influenced by any of a number of social and cultural processes. Indeed, Internet searches occur in rich sociocultural environments, in which people converse, attend to the concerns of daily life, and consume various media (e.g., television, newspapers). We do not consider these phenomena to be separate from widespread interest but assume them to be an integral part of it. Sociocultural phenomena not only shape but also reflect and respond to widespread interest. Complex interpersonal processes are as much a product of psychology as are intrapersonal ones.

Conclusion

Widespread interest determines important social, economic, and political outcomes. Whether interest in an idea is inhibited or sustained can determine whether it becomes a forgotten fad or a cherished cause or movement. Yet psychological approaches have rarely been used to examine widespread interest (Coman, Brown, Koppel, & Hirst, 2009). The present studies found that the interest of national and international populations swells and subsides according to two common memory patterns observed in laboratory examinations of individuals. Phenomena that have been observed for individuals and for memory performance may therefore be applied to the study of other sorts of mental processes (e.g., interest) and at much larger scales.

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