Evolution and Human Behavior 39 (2018) 67–75

Contents lists available at ScienceDirect

Evolution and Human Behavior

journal homepage: www.ehbonline.org

Original Article

Origins of sinister rumors: A preference for threat-related material in the supply and demand of information

Timothy Blaine [a,*], Pascal Boyer [a,b]

[a] Department of Anthropology, Washington University in St. Louis, One Brookings Drive, St. Louis, MO, USA
[b] Department of Psychology, Washington University in St. Louis, One Brookings Drive, St. Louis, MO, USA

ARTICLE INFO

Article history:
Initial receipt 21 June 2017
Final revision received 2 October 2017

Keywords:
Cultural transmission
Rumors
Threat detection
Error management
Cultural beliefs
Negativity bias

ABSTRACT

Many rumors convey information about potential danger, even when these dangers are very unlikely. In four studies, we examine whether micro-processes of cultural transmission explain the spread of threat-related information. Three studies using transmission chain protocols suggest a) that there is indeed a preference for the deliberate transmission of threat-related information over other material, b) that it is not caused by a general negativity or emotionality bias, and c) that it is not eliminated when threats are presented as very unlikely. A forced-choice study on similar material shows the same preference when participants have to select information to acquire rather than transmit. So the cultural success of threat-related material may be explained by transmission biases, rooted in evolved threat-detection and error-management systems, that affect both supply and demand of information.

1. Introduction

1.1. Cultural success of threat-related information

Threat-related information is a central theme of many rumors, as well as urban legends and religious myths (Allport & Postman, 1947; Boyer & Parren, 2015; Difonzo & Bordia, 2007; Fessler, Pisor, & Navarrete, 2014; Heath, Bell, & Steinberg, 2001; Stubbersfield, Tehrani, & Flynn, 2014). The frequency of such themes may be explained as the effect of various biases that occur at reception, encoding, retrieval and transmission. In the studies reported here, we investigated the latter factor, evaluating a) to what extent people spontaneously select threat-information as the most relevant material to transmit to others (as this would account for the large supply of such information), and b) how people focus on threat-information as the kind of material they want to hear more about (expressing a demand for such material). We used transmission chains in which participants deliberately chose to pass on some items to the next "generation" and exclude other material, as well as a forced-choice task for people to select items they want to know more about. The results suggest that threat-items are indeed supplied and requested more often than comparable information, which may account for their prevalence in cultural transmission.

Previous studies of transmission shed light on very general factors that may affect the cultural spread of particular kinds of material. For instance, people may want to transmit information with salient emotional content. Newspaper stories that become "viral" in terms of Internet transmission, contain more emotional material than other stories (Berger & Milkman, 2012). Urban legends that elicit disgust are better transmitted than control items (Heath et al., 2001). Another related factor is a form of "negativity bias" (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001) that has been observed in many domains of attention and memory (Ito, Larsen, Smith, & Cacioppo, 1998; Rozin & Royzman, 2001), as well as in the transmission of information (Heath, 1996). Negativity affects not just transmission but also belief, as people judge as more plausible the same information when it is framed in negative terms (e.g., "10% of heart transplants fail within a year") rather than with positive framing (e.g., "90% of heart transplants are fine after a year") (Fessler et al., 2014; Hilbig, 2009, 2012).

However, negativity may be too broad a category. In functional terms, it is difficult to see why minds should be biased towards negative material in general. The bias reported may be more specific, as a focus on information related to potential danger, which makes more functional sense (Pratto & John, 1991). As Fessler et al. report, this would explain belief in negatively framed material (Fessler et al., 2014). The framing effect illustrates error-detection mechanisms. When an external situation cannot be evaluated with certainty, an organism should be designed to err on the side of caution when the cost of false-alarms is lower than that of misses, and conversely be more adventurous when the costs are reversed (Haselton & Buss, 2000; Haselton & Funder, 2006). On functional and evolutionary grounds, then, a focus on threat-related information makes sense. As Fessler et al. point out, that would apply not just to

* Corresponding author.
E-mail addresses: tblaine@wustl.edu (T. Blaine), pboyer@wustl.edu (P. Boyer).

https://doi.org/10.1016/j.evolhumbehav.2017.10.001
1090-5138/

evaluating, but also to transmitting information, in situations in which the cost of misses may appear greater than that of false alarms (Altshteyn, 2014; Fessler et al., 2014). Indeed, previous studies suggest that people tend to judge sources of threat-information as more competent than sources of neutral or negative material (Boyer & Parren, 2015), which would also suggest a specific focus on threat-related material.

After completion of the studies reported here, we were apprised of a series of similar experiments conducted by Bebbington et al. and published in *Evolution and Human Behavior* (Bebbington, MacLeod, Ellison, & Fay, 2017). These studies report on the persistence of negative material through chains of transmission, on theoretical grounds similar to those presented here. However, the materials used do not address the question of probability (Do people transmit information about unlikely but very costly threats?), nor do they differentiate between generally negative content on the one hand, and fitness threats on the other.

That is why, in the studies reported here, we measured the transmission potential of items clearly identified as threat-related, over not just neutral control items, but also over generally negative items, to evaluate the specificity of threat-related information in social transmission.

1.2. Supply and demand: transmission-chains and requests for information

In three of the studies reported here, we evaluated the privilege of threat-related information in chains of transmission, in which participants receive some material and transmit part of it to a next generation of participants. This is repeated several times, in a method originally designed by Frederic Bartlett in his studies of story transmission (Bartlett, 1932). The extent that threat items survive such cycles of transmission better than control items provides a laboratory equivalent of the processes that make such threat information widespread in actual human groups.

In recent studies, the factor that determined which items were passed on from one generation to the next was free recall (Eriksson & Coultas, 2014; Miton, Claidière, & Mercier, 2015; Stubbersfield & Tehrani, 2013). The decision to use recall is based on a straightforward assumption, that culturally transmitted material must first be recalled by individuals, so that differences in recall potential may be a simple explanation for differences in the cultural success of different types of material (Boyer & Ramble, 2001; Goody, 1977; Rubin, 1995). Considering the cultural practice of bloodletting, for instance, the recall-based transmission of specific items of this procedure closely matches, and may explain, their cultural spread (Miton et al., 2015).

However, individual recall is only one among many factors affecting the spread of cultural material. That is, while minimal recall is of course necessary, in many cases material can become culturally widespread because of a stronger motivation to transmit (Morin, 2016). That is the case for jokes, which are very stable in content even though they are often poorly recalled, because of an urge to tell them shortly after hearing them (Maher & Van Giffen, 1988). In early accounts of traditions, it was often assumed that higher memorability was both necessary and sufficient for greater transmission of cultural material (see e.g., Boyd & Richerson, 1985, p. 8ff.; Boyer, 1990). But, as Morin demonstrates, in many cases the persistence of traditions depends on just on memorability, but also on factors such as the frequency of transmission events and specific motivations (Morin, 2013, 2016). That is why we focused on deliberate transmission, forcing participants to choose, among the various items that describe a particular product, which ones they would transmit to a friend who may want to acquire that product.

The deliberate selection of some material, to convey to others, constitutes the supply side of cultural transmission. On the other side, the cultural prevalence of threat-related information may also be affected by demand, by the fact that people prefer to hear about potential dangers rather than other types of material, notably because of the error-management biases mentioned above. There is of course considerable observational evidence that people are motivated to hear about potential dangers, in the success of horror fiction, of conspiracy websites, and of sensationalist reporting.

To check that this demand actually targets threat-related information, as opposed to generally negative or emotional material, our fourth study uses a forced-choice protocol, with the same materials as the transmission-chain studies. To the extent that participants in this controlled setting choose to receive more information about potential danger than about negative, neutral or positive aspects of a situation or product, this would confirm that there is indeed demand for information about threats.

1.3. Low probability threats are still threats

Another important aspect of cultural myths, urban legends, etc., is that they often describe very remote contingencies, such as, e.g., the dangers of having crocodiles as pets, or of drying a wet cat in a microwave oven (Brunvand, 1981). Still, they are transmitted more readily than less salient, but otherwise more useful material. In the same way, sensationalistic reporting is known to emphasize events regardless of their probability, e.g., highlighting plane crashes more than automobile accidents. One possible explanation might be that human threat-detection psychology is sensitive to the magnitude of danger, but not to the measurement of risk as the multiplication of danger by probability, as is suggested by various models in the "heuristic and biases" tradition (see e.g. Fischhoff, Watson, & Hope, 1984; Slovic, 2016). Alternatively, the apparent neglect of information about probability may reflect a mismatch between modern conditions and the typical situations under which threat-detection systems evolved (Cosmides & Tooby, 2006). Indeed, threat-detection systems preferentially track dangers that were present in environments of human evolutionary adaptedness, which is why children in modern conditions fear non-existent wolf-like predators, while ignoring more likely threats from guns or electricity (Boyer & Bergstrom, 2011). Finally, error-management would imply that very unlikely occurrences trigger the same "better safe than sorry" attitude than likely ones, if the cost of misses is high enough. All three models would predict that the propensity to transmit danger-related information would remain the same, even if the threat is explicitly described as unlikely. In the transmission studies reported here, we systematically manipulated information concerning the probability of the events described, and expected that it would not substantially affect the choice of threat-related items for further transmission.

2. Study 1

In this and the next two studies, we asked whether people choose to transmit threat-related information over other kinds of negative or neutral information in situations leading to a well-informed decision. We designed a transmission-chain study with various types of competing threat, negative, and neutral information, and used survival analysis to evaluate differences in their trajectories throughout several generations of transmission.

2.1. Materials pretest

This study required operational distinctions between threat-related information and other kinds of negative information. In order to do this, we wrote and pretested a series of scripts describing various features of a handful of fictitious products. Market goods present a familiar situation in which commitments are often made based on some balanced evaluation of positive, negative, and potentially harmful aspects, and where mentions of all three are equally anticipated. We prepared these product scripts as reports of the kind published by consumer associations. For the intended American participants, such reports are a resource commonly accessed for an unbiased assessment of product benefits, drawbacks, and risks. They differ from advertisements in that people expect them to be unbiased. We designed our transmission study so that participants would be asked to select the items that they believed were most important for a friend to know before purchasing the product.

Each script included two sentences of threat-related content, two sentences of threat-unrelated negative content, and four sentences of neutral content describing basic product features. We made sure that the scripts were of similar length in word and sentence count, and that the name of the product was mentioned the same number of times. See examples of such in Supplemental materials.

In the pretest, we asked participants to read one of these scripts, and then rate eight sentences from that script on three 7-point Likert-scales according to the following dimensions: a) "How useful is this statement for the product described?" (1: Not at all useful, 7: Extremely useful), b) "Does this statement describe something positive or negative?" (1: Negative, 7: Positive), c) "Does this statement describe a potential danger?" (1: Not at all, 7: Completely). Participants were given the opportunity to earn a \$0.10 bonus by correctly recalling the name of the product. Participants answering the catch question incorrectly were assumed not to have read the survey closely. We excluded these participants' data from analysis.

We prepared six stories. We pretested materials for a one-step hair dye product and an ergonomic pillow with 120 Amazon Mechanical Turk™ (MTurk™) workers (ages 20 to 69, $M = 33.4$, $SD = 10.9$, 52 women, 96 self-identified as White) for a \$0.40 wage. We excluded 19 participants with incorrect answers to the catch question ($N = 101$, ages 20 to 65, $M = 32.6$, $SD = 10.0$, 45 women, 81 White). In a separate survey, we pretested materials about a custom running shoe brand and a portable humidifier with 120 MTurk™ workers as well (ages 19 to 69, $M = 35.7$, $SD = 11.7$, 46 women, 93 White), and 17 participants were excluded by performance on the catch question ($N = 103$, ages 19 to 69, $M = 36.4$, $SD = 12.1$, 41 women, 83 White). Finally, we pretested materials about a topical acne medication and a second ergonomic pillow script with 121 MTurk™ workers (ages 21 to 67, $M = 33.6$, $SD = 10.1$, 46 women, 90 White). In this last survey, we excluded 15 participants by catch question ($N = 104$, ages 21 to 67, $M = 33.9$, $SD = 12.1$, 41 women, 80 White).

We accepted as "Threat" items only those items that were rated by a majority of participants as a) useful (above 4 on Likert-scale), b) negative in tone (below 4 on Likert-scale) and c) potentially dangerous (above 4 on Likert-scale). "Negative" items were accepted only if the items were rated as a) useful, b) negative in tone and c) not potentially dangerous (below 4 on Likert-scale). "Neutral" items were accepted only for items rated as a) useful, b) not negative (above 4 on Likert-scale), and c) not dangerous (above 4 on Likert-scale). Additionally, we used Threat and Negative items only when the ratings demonstrated a) a statistically significant difference in the "danger" rating between Threat and Negative, and b) no statistically significant difference in the "negativity" rating or "usefulness" ratings.

Three scripts met these criteria: (1) the one-step hair dye, (2) the custom running shoe brand, and (3) the topical acne medication. These are included in Supplemental materials.

2.2. Methods

2.2.1. Participants

We conducted a transmission chain for each product, for a total of three parallel chains. We designed each of these studies with five generations of 25 participants for a recruitment goal of 125 MTurk™ workers correctly recalling the product's name. Inevitably, some participants incorrectly answered this catch question, in which case we redistributed their particular survey. For this reason, surveys variably reached >125 participants. All surveys were distributed to English-speaking adults at or above 18 years old, living in the United States, for \$0.25 compensation. Correct answers to the bonus question earned an additional \$0.10.

We distributed the script about the one-step hair dye to 168 participants (ages 20 to 71, $M = 34.9$, $SD = 11.3$, 85 women, 40 self-identified as an ethnicity other than White). The script about custom running shoes reached 133 participants (ages 18 to 74, $M = 35.9$, $SD = 11.3$, 64 women, 26 self-identified as an ethnicity other than White). Finally, 135 participants completed surveys about the topical acne medication (ages 20 to 67, $M = 35.2$, $SD = 11.4$, 67 women, 26 self-identified as an ethnicity other than White).

2.2.2. Materials

Each of the consumer report scripts meeting pretest criteria were presented as a paragraph, accompanied by a checkbox list of the eight itemized sentences. Threat content and Negative content appear with no mention of likelihood. Examples of scripts are available in Supplemental materials.

2.2.3. Design and procedure

We used a between subjects design. Participants received only one script of the three. Over five generations of transmission, surveys were organized into 25 "chains". This meant that as a particular item of information was or was not transmitted, its path throughout the overall study could be traced by its presence or absence in a line of surveys across generations.

For the first generation of each study, we distributed a seed survey to 25 participants. Participants read the consumer report in paragraph form. The survey then provided participants a hypothetical story about a friend considering purchasing this product, and the question: "Which items about the product are most important to tell [your friend] so that [she] makes a good decision?" Participants were asked to select seven of the eight sentences about the product from an itemized list to share with that friend. Again, these pretested sentences consisted of two Threat items, two Negative items, and four Neutral items, with order randomized. Each sentence began with the name of the brand.

We then generated 25 unique surveys from responses to the seed survey, updating the list in each new survey with the seven items chosen by each of the first generation participants. This second generation then asked participants to pass on six of the seven items. After all 25 surveys were completed with correct catch answers, the process was repeated with a third generation, and so on. Each generation asked for one less item than the previous generation. We ran five generations for each script, for a total of 101 surveys per script and 303 surveys for Study 2. Information was never added to surveys.

2.2.4. Quantitative methods

We used survival analysis to evaluate differences in item transmission, and Kaplan-Meier survival probability estimation to determine whether or not transmission was due to the chance probability of selecting an item according to the natural reduction in item volume (Bland & Altman, 1998).

Survival analysis is a method commonly used in biomedical science to trace the presence of a condition over time. Each item possesses its own time function drawn from the presence or absence of that item in each generation of the study. Survival curves for two conditions within a study may be compared using a log-rank test (Mantel-Cox test) whose test statistic approximates a chi-square with 1 degree of freedom ($\chi^2 = 3.84$, reject H_0 if $\chi^2_{exp} > 3.84$). We "right-censor" data at five generations, meaning that we stop measurement after the fifth generation. For generations where an item appears, we declare that item "alive". We declare an item "dead" when it has not been selected for transmission. In the log-rank test used to compare the survival of two items, actual survival count is recorded at each generation for each item, and compared against an expected survival count at corresponding generations (Bland & Altman, 2004).

We compared conditions pairwise. We began with a log-rank test of the survival functions for Threat items versus Negative items; in other words, we compared the likelihood that either of the two Threat items survived versus the likelihood that either of the two Negative items survived. Finally, we compared survival for Threat items against Neutral items, and Negative items against Neutral items.

All p-values for chi-square scores are calculated at $\alpha = 0.05$ significance level. We have included an example of the log-rank test used in our analysis in Supplemental materials.

Charts included in this report depict the Kaplan-Meier survival probability for each item at each generation for each script. This value indicates the likelihood that the given item will be passed on to the next generation. This survival probability is given by the function:

$$S_{(t+1)} = S_t * [(N_{t+1} - D_{t+1})/N_{t+1}]$$

where $S_{(t+1)}$ is the survival probability of the current generation, and S_1 is the survival probability of the previous generation. For the first generation in a series, $S_1 = 1$ for any item because no participants have dropped out for that item. N_{t+1} is the number of participants at risk of dropping out at the start of the current generation, and D_{t+1} is the number of participants that dropped out at the conclusion of the current generation.

For any given group of Threat, Negative, or Neutral items, the chance probability of transmitting a given item type, assuming no differences between types, can be calculated as a cumulative hypergeometric probability.

$$h(x \leq \mathrm{x}; N, n, k) = [{}_kC_x][{}_{N-k}C_{n-x}]/[{}_NC_n]$$

In which N is the size of the given population, and k is the number of items of interest within that population. The hypergeometric probability h is the likelihood that x items of interest appear in a random sample of n items from population N. The cumulative hypergeometric probability is the sum of the hypergeometric probability from 0 to x. For example, a survey in generation 1 has two Threat items out of eight total items, so the cumulative probability of one or both of those items being among the seven items transmitted to generation 2 is expressed as follows:

$$h(x \leq 2; N, n, k) = h(x = 0; 8, 7, 2) + h(x = 1; 8, 7, 2) + h(x = 2; 8, 7, 2)$$
$$h(x \leq 2; 8, 7, 2) = 0 + 0.25 + 0.75 = 1$$

2.3. Results and discussion

In total, 43 participants failed to recall the name of the hair dye product, and thus were excluded from analysis of that study ($N = 125$, ages 20 to 71, $M = 35.9$, $SD = 11.7$, 65 women, 26 self-identified as an ethnicity other than White). For the custom running shoe script, 8 participants were excluded ($N = 125$, ages 18 to 74, $M = 36.3$, $SD = 11.4$, 60 women, 24 self-identified as an ethnicity other than White). 10 participants were excluded from analysis for the topical acne medication script ($N = 125$, ages 20 to 67, $M = 35.2$, $SD = 11.4$, 61 women, 24 self-identified as an ethnicity other than White).

For all three scripts, Threat information chains were significantly longer than Negative information chains (*HAIR DYE*: $\chi^2 = 21.2$, $p < 0.01$; *SHOES*: $\chi^2 = 42.6$, $p < 0.01$; *ACNE*: $\chi^2 = 32.4$, $p < 0.01$). Threat content was also significantly more likely to survive than Neutral content (*HAIR DYE*: $\chi^2 = 56.4$, $p < 0.01$; *SHOES*: $\chi^2 = 45.2$, $p < 0.01$; *ACNE*: $\chi^2 = 62.6$, $p < 0.01$). Negative content was significantly more likely to survive than Neutral content in two of the three scripts (*HAIR DYE*: $\chi^2 = 5.0$, $p = 0.02$; *SHOES*: $\chi^2 = 0.77$, $p = 0.4$; *ACNE*: $\chi^2 = 3.1$, $p = 0.08$).

Results show that participants favored Threat content over Negative content when sharing information that they believed contributed to another person's decision-making. This holds true in all cases when Threat and Negative content survival is compared by group and for nearly all cases when Threat and Negative content survival is compared item-by-item (see Supplemental Materials). Fig. 1 illustrates the survival probability of Threat, Negative, and Neutral items in each script.

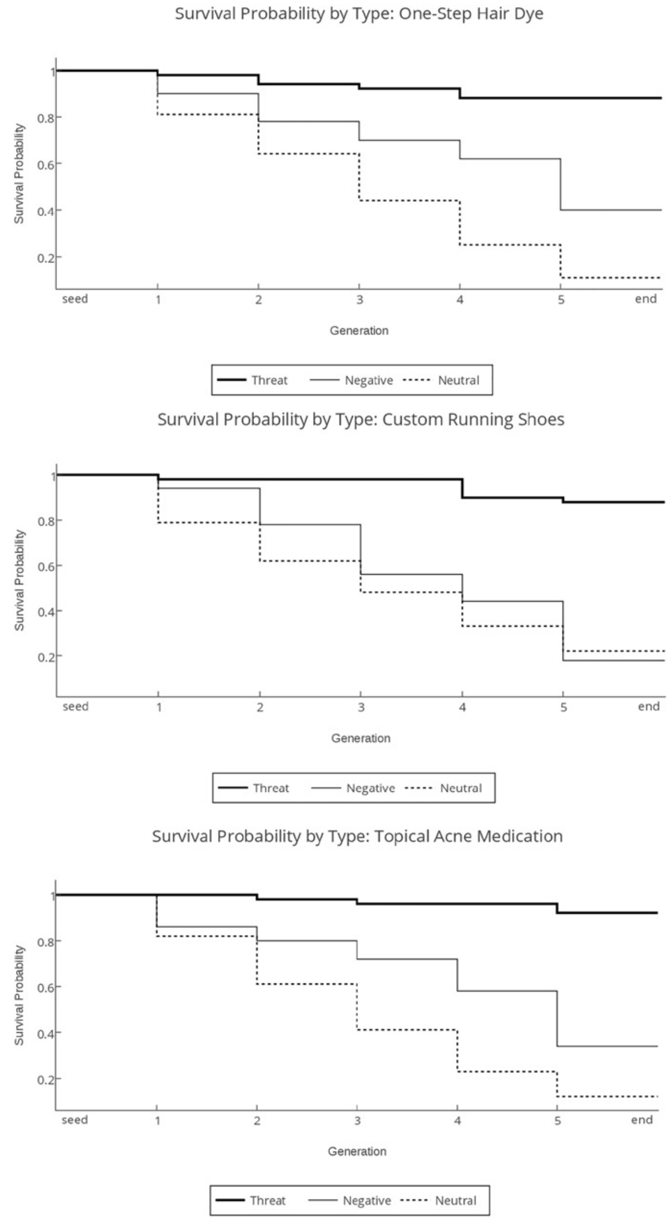

Fig. 1. Survival probabilities for Threat, Negative, and Neutral content in Study 1.

3. Study 2

To test whether people continue to transmit threat-related information when it is presented as less likely, we modified the Threat items in each script of Study 1, to describe them as low-probability events against Negative items with unstated probability.

3.1. Methods

3.1.1. Participants

The hair dye script was distributed to 156 participants (ages 20 to 72, $M = 36.6$, $SD = 13.4$) of which 83 were men and 115 were White. The running shoe script was given to 138 participants (ages 19 to 75, $M = 35.8$, $SD = 11.9$) with 68 men and 117 White. The acne medication script reached 139 participants, of whom 58 were men and 116 were White (ages 18 to 98, $M = 37.4$, $SD = 12.5$).

3.1.2. Materials

In order to systematize our statement of low-probability, we modified Threat items with the same two statements: "In 2% of users…" and "rare/rarely". This was repeated for each script. Example modifications are pictured in Table 1.

3.1.3. Design and procedure
Identical to Study 1.

3.1.4. Quantitative methods
Between participants: log-rank test and Kaplan-Meier survival probability estimation.

3.2. Results and discussion

For the hair dye script, 31 participants incorrectly answered the catch question ($N = 125$, ages 20 to 72, $M = 37.8$, $SD = 13.6$, 66 women, 98 White). 8 participants were excluded from the shoes script ($N = 125$, ages 19 to 75, $M = 36.7$, $SD = 12.3$, 62 men, 104 White). In the acne medication script, 14 participants were excluded by catch question ($N = 125$, ages 19 to 98, $M = 35.2$, $SD = 11.4$, 49 men, 107 White).

According to log-rank tests, low-probability Threat information was significantly more likely to be shared than Negative information (*HAIR DYE*: $\chi^2 = 12.9$, $p < 0.01$; *SHOES*: $\chi^2 = 28.5$, $p < 0.01$; *ACNE*: $\chi^2 = 6.9$, $p < 0.01$). Threat content was always significantly more likely to survive than Neutral content (*HAIR DYE*: $\chi^2 = 31.3$, $p < 0.01$; *SHOES*: $\chi^2 = 29.7$, $p < 0.01$; *ACNE*: $\chi^2 = 49.8$, $p < 0.01$). Negative content and Neutral content were equally likely to be transmitted in one script (*SHOES*: $\chi^2 = 2.0$, $p = 0.2$), there was a trend to a difference in another one two of the three scripts (*HAIR DYE*: $\chi^2 = 3.67$, $p = 0.05$); and the third story resulted in a significant difference (*ACNE*: $\chi^2 = 9.8$, $p < 0.01$).

Again, participants were significantly more likely to share Threat content than Negative content, even though Threat content less likely to be useful. We did observe more robust survival performance from certain Negative items, suggesting that the preference for Threat information may not be as strong as in Study 2, or diminished to some degree by lowered likelihood and competition from relevant, non-threat-related Negative information. Fig. 2 reports the survival probability of Threat, Negative, and Neutral items by script.

A log-rank test reported no significant difference between Threat content transmission chains in Study 1 and Study 2 (*HAIR DYE*: $\chi^2 = 2.32$, $p = 0.13$; *SHOES*: $\chi^2 = 2.22$, $p = 0.14$; *ACNE*: $\chi^2 = 3.71$, $p = 0.05$). This means that Threat content was equally likely to be transmitted when presented without probability and when presented at low-probability in otherwise identical context.

4. Study 3

Until this point, we tested participants' preferences for selecting between Threat, Negative, and Neutral information for transmission. In more naturalistic contexts, conversation generally balances negative information against information that suggests potential benefits. This presented an opportunity to study whether the observed preference for transmitting Threat information persisted when participants also had access to relevant Positive information.

4.1. Materials pretest for positive items

For the three stories used in Studies 1 and 2, we wrote additional items about benefits related to product use. Following the preference for low-probability Threat information documented in Study 2, we included statements of high-probability for each Positive item. As before, we modified items according to two statements: "In 95% of [users]…" and "almost always". All pretest questions, including the catch question, were identical to those asked in Study 1. We accepted as Positive content items if they rated [1] Useful (above 4 on "Usefulness"), [2] Positive (above 4 on "Positivity" scale), and [3] Non-Dangerous (below 4 on "Dangerousness" scale).

The pretest was distributed to 122 participants between 20 and 63 years of age ($M = 34.9$, $SD = 12.2$), of which 63 were women and 99 self-identified as White. Of these participants, 23 were excluded from analysis due to incorrect answers on the end-of-survey catch question. The remaining 99 participants were between 20 and 63 years of age ($M = 36.2$, $SD = 12.5$). 54 were women and 79 self-identified as White.

Positive information items chosen for Study 4 from among the results are listed in Table 2.

4.2. Methods

4.2.1. Participants
The hair dye script was distributed to 172 participants (ages 19 to 69, $M = 34.8$, $SD = 10.6$) of which 84 were men and 136 were White. The running shoe script was given to 128 participants (ages 19 to 74, $M = 36.9$, $SD = 11.8$) with 60 men and 104 White. The acne medication script reached 134 participants, of whom 62 were men and 103 were White (ages 20 to 71, $M = 35.8$, $SD = 11.4$).

4.2.2. Materials
Each story included two Positive items from Table 2 and two corresponding low-probability Threat items from Table 1, as well as two Negative items and two Neutral items presented without probabilities.

4.2.3. Design and procedure
The transmission design was identical to Studies 1 and 2.

4.2.4. Quantitative methods
Between participants: log-rank test and Kaplan-Meier survival probability estimation.

4.3. Results and discussion

Forty-seven participants incorrectly answered the catch question in the hair dye script ($N = 125$, ages 21 to 69, $M = 35.3$, $SD = 10.8$, 73 women, 100 White). In the running shoe script, 3 participants were excluded ($N = 125$, ages 19 to 74, $M = 36.8$, $SD = 11.9$, 60 men, 102 White). 9 participants were excluded by catch question from the acne medication script ($N = 125$, ages 20 to 71, $M = 36.2$, $SD = 11.1$, 54 men, 97 White).

Log-rank tests performed on the acne medication and running shoe stories showed that participants were significantly more likely to share

Table 1
Study 2 Threat items modified to emphasize a low-probability of threat in Study 2.

	Study 1 (original Threat content, probability unstated)	Study 2 (Threat content modified to occur at low-probability)
Hair dye	[…] may burn or irritate the scalp if applied to certain skin types. […]	[…] may burn or irritate the scalp if applied to rare skin types […]
	[…] can cause severe allergic reactions. […]	[…] can cause severe allergic reactions in 2% of users […]
Shoes	[…] strap design can cause sprained ankles when used for activities other than running. […]	[…] strap design can cause sprained ankles in 2% of users when used for activities other than running. […]
	[…] smooth sole can cause runners to slip and fall on certain surfaces. […]	[…] smooth sole can on rare occasions cause runners to slip and fall on certain surfaces. […]
Acne	[…] may burn if applied to certain skin types. […]	[…] may burn if applied to certain rare skin types. […]
	[…] can cause dizziness if used while dehydrated. […]	[…] can cause dizziness in 2% of users if used while dehydrated. […]

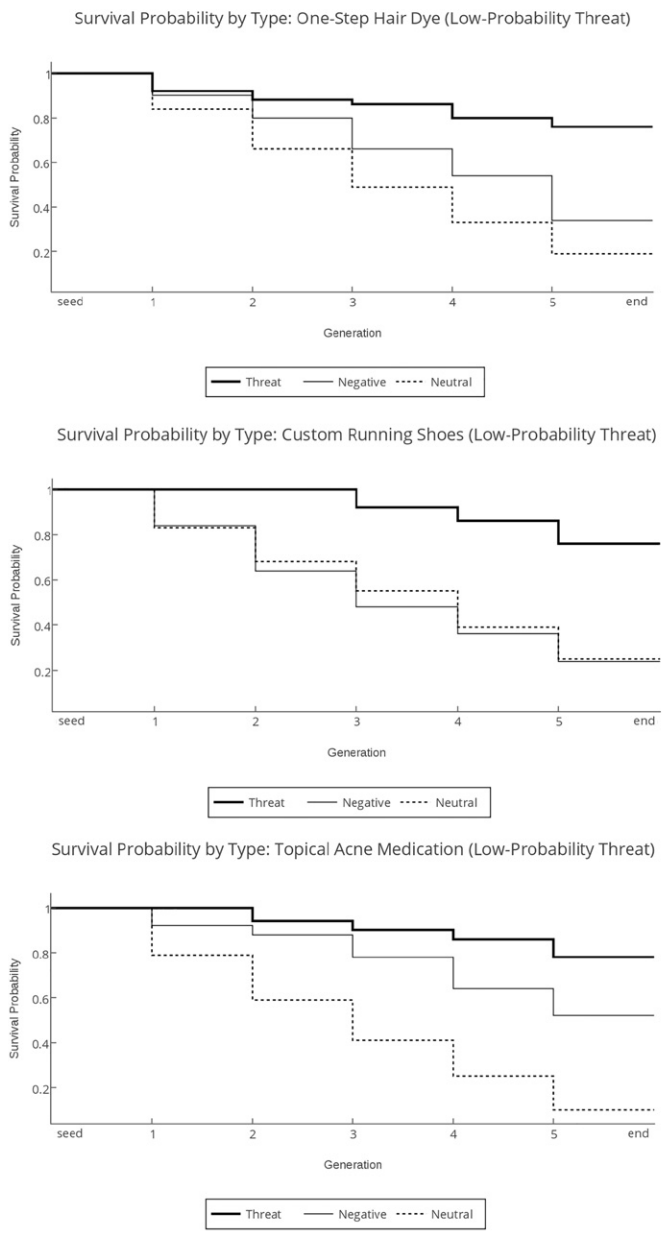

Fig. 2. Survival probabilities for Threat, Negative, and Neutral content in Study 2.

low-probability Threat information than Negative information (*SHOES*: $\chi^2 = 25.7$, $p < 0.01$; *ACNE*: $\chi^2 = 7.6$, $p < 0.01$) and equally likely to share low-probability Threat and high-probability Positive information (*SHOES*: $\chi^2 = 0.5$, $p = 0.5$; *ACNE*: $\chi^2 = 0.3$, $p = 0.6$). Log-rank tests on results from the one-step hair dye story indicate that participants were significantly more likely to transmit low-probability Threat information than high-probability Positive information ($\chi^2 = 20.8$, $p < 0.01$) and were equally likely to transmit low-probability Threat information and Negative information ($\chi^2 = 2.94$, $p = 0.09$).

Threat items were always significantly more likely to survive than Neutral content (*HAIR DYE*: $\chi^2 = 32.3$, $p = 0.01$; *SHOES*: $\chi^2 = 20.0$, $p < 0.01$; *ACNE*: $\chi^2 = 41.5$, $p < 0.01$). High-probability Positive items were significantly more likely to be transmitted than Neutral items in two of the scripts (*HAIR DYE*: $\chi^2 = 2.1$, $p = 0.1$; *SHOES*: $\chi^2 = 20.0$, $p < 0.01$; *ACNE*: $\chi^2 = 41.5$, $p < 0.01$). Likewise, high-probability Positive items were more likely to be transmitted than Negative items in two of the scripts (*SHOES*: $\chi^2 = 20.1$, $p < 0.01$; *ACNE*: $\chi^2 = 5.1$, $p = 0.02$), while Negative content was more likely to be transmitted in the third script (*HAIR DYE*: $\chi^2 = 7.2$, $p < 0.01$). Fig. 3 illustrates these results.

Log-rank testing reported no significant difference between low-probability Threat content transmission chains in Study 2 and Study 3 (*HAIR DYE*: $\chi^2 = 0.9$, $p = 0.3$; *SHOES*: $\chi^2 = 1.8$, $p = 0.2$; *ACNE*: $\chi^2 = 2.8$, $p = 0.09$). In other words, low-probability Threat information was equally likely to be transmitted with and without competition from high-probability Positive information.

Table 2
Positive items emphasizing the high likelihood of positive information in Study 3.

	Positive items
Hair dye	[…] proven to brighten radiant hair in 95% of brunettes. […] […] will always give more body and volume to your hair. […]
Shoes	[…] allows 95% of runners to improve their running average. […] […] can almost always be sent in free of charge for wear and tear repair. […]
Acne	[…] proven to clear up 95% of facial acne cases. […] […] can almost always be returned for a full refund if the treatment doesn't work. […]

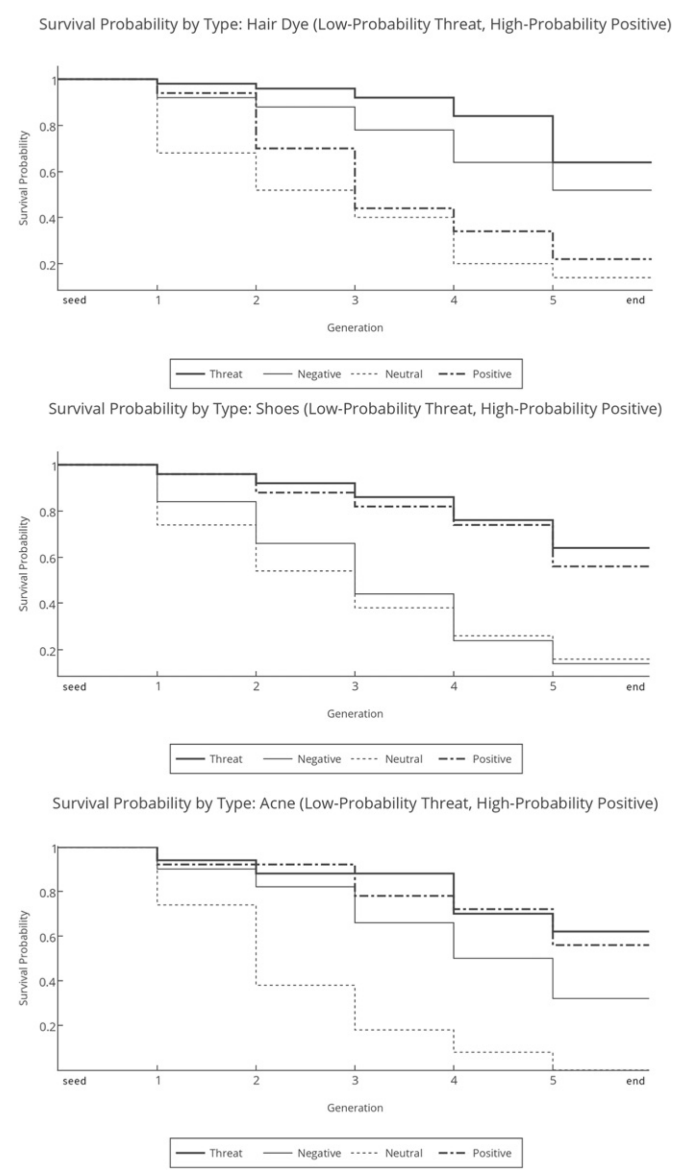

Fig. 3. Survival probabilities for Threat, Negative, Neutral and Positive content in Study 3.

5. Study 4

In Study 1, people deliberately transmitted Threat information over non-threatening Negative information. Study 2 found the same results even when Threat information was of low-probability, and Study 3 expanded on this by showing that people continue to transmit very unlikely Threat information at a rate comparable to their transmission of very likely Positive information. In other words, positive information must be described as much more likely than threat-information, in order to reach the same probability of transmission. These results depict people's willingness to supply Threat information, but what about the demand for such information?

The demand side of cultural transmission is relevant here, as culturally transmitted information about e.g. imagined threats, is often conveyed in the form of conversations, in which people seek additional information about some facts, or in the context of Internet navigation, when people click on a link because a title captured their attention: in other words, because they are seeking additional information on potential threats.

In approaching this question, we devised a survey in which participants selected content they believed was most important to know more about in order to make a good decision. Here, item selection indicated an interest in receiving more information about those items, which in turn signaled the perceived usefulness of that particular informational type. The available statements described relatively simple events to imply the potential for elaboration about the event mentioned. For instance, a participant's choice to learn more about how an acne medication might burn their skin suggests an interest in learning when, how, or why this might occur, and be understood as demand for more information about avoiding harm. Likewise, a participant's choice to learn more about how an acne medication might be refundable suggests an interest in how to obtain reward. Similar consideration is given to Negative and Neutral items.

In any case, the design presented a tradeoff between acquiring different kinds of information at the expense of another, with different implied consequences, so that we might observe preferences for one kind of information over the other.

5.1. Methods

5.1.1. Participants

The survey was completed by 148 participants aged 19 to 83 ($M = 39.1$, $SD = 13.8$). 94 participants were female, and 48 participants self-identified as an ethnicity other than White.

5.1.2. Materials

We used the product stories from Study 3, where Threat information was stated at low-probability and Positive information was stated at high-probability. In the survey, each story was stated in paragraph form, and as a list of eight items below that paragraph. As in Study 3, each list consisted of the two unlikely Threat items, two likely Positive items, two Negative items with likelihood unstated, and two Neutral items with likelihood unstated.

5.1.3. Design and procedure

Participants each read one of the three stories. They were then presented a scenario in which a hypothetical friend considered purchasing the product mentioned in the story. Participants were asked to select three of the listed statements that they thought their friend should seek clarification on in order to “make a good decision” about their purchase. At the end of the survey, the catch question from Study 3 was used to assess participant attention to the material.

5.1.4. Quantitative methods

Item analysis and a series of independent samples *t*-tests at significance level $\alpha = 0.05$, two-tailed, were used to compare the number of Threat, Negative, Neutral, and Positive items chosen by participants for elaboration. We calculated the proportion of Threat, Negative, Neutral, and Positive items in each participant's response, and then found the mean of these proportions for each item type. The means were then compared using t-tests.

5.2. Results and discussion

Sixteen participants provided incorrect answers to the catch question. The remaining 132 participants were aged 21 to 83 ($M = 39.8$, $SD = 13.8$), of whom 87 were female, and 43 participants self-identified as an ethnicity other than White.

Out of a possible 264 times, low-probability Threat items were selected for elaboration 167 times (63%). Negative information was selected 99 out of a possible 264 times (38%). Participants selected significantly more low-probability Threat items for elaboration than Negative items, $t(131) = 5.96$, $p < 0.01$, two-tailed.

High-probability Positive items were selected 91 out of a possible 264 times (34%), so it follows that participants selected significantly more low-probability Threat items for elaboration than high-probability Positive items, $t(131) = 6.40$, $p < 0.01$, two-tailed. No significant difference was found between the selection of Negative and high-probability Positive items were chosen, $t(131) = 0.73$, $p = 0.5$, two-tailed.

An analysis of how frequently particular types of information were selected together (e.g., how often a participant selected zero Threat items vs. one Threat item vs. both Threat items) shows that Threat items were most often selected together while Negative items were least often selected together. Table 3 shows these patterns of selection.

The premise of this study was to provide a situation in which participants selected items of information they felt were necessary to better understand. We found that participants wanted to learn more about threat information over all other types of information, regardless of its likelihood to occur. Additionally, threat information was most frequently selected together, suggesting a trend towards grouping in the demand for such information.

6. General discussion

In four studies, we observed a privilege of threat-related information over other positive or neutral items, but also over negative material. In transmission chains, people preferred to transmit threat-related information (Study 1). Adding explicit information to the effect that the dangers described were unlikely did not modify this preference for threat-related items over negative items (Study 2). Even adding potentially more relevant positive information about the products left the threat-related information items as more likely to survive cultural transmission than any other material (Study 3). Finally, a forced-choice paradigm on these same materials showed that participants chose to seek more information about threat-items than about other aspects of the products described (Study 4).

Taken together, these results support the hypothesis, that threat-related information is selected for social transmission, in preference to other kinds of information. As the less transmitted items include negative information, we should not interpret the advantage of threat-information as a form of negativity bias. Also, the results confirm that threat-

Table 3
Frequency participants chose to learn more about 0, 1, or 2 items of an informational type in Study 4.

	Number of times participants chose 0, 1, or 2 items of a type		
	Choose 0	Choose 1	Choose 2
Unlikely threat	25	47	60
Negative	48	69	15
Neutral	94	35	3
Likely positive	59	55	18

information is selected even when the danger is described as very unlikely. We might expect people to share knowledge based on the likelihood that it will applied in the future. This expectation assumes that cultural exchange is utilitarian to some degree, when ample evidence shows that it is also subject to broader social and cognitive motivations. Finally, the results suggest that the preference for threat-information is present in both the supply of and demand for relevant information about a product. Our materials included a variety of stories describing many different instances of danger, showing that this effect applies to a general domain of threat information.

Such selective preference may contribute to explaining the cultural spread of rumors, myths, and urban legends that prominently feature danger as a narrative component but often describe very rare or peculiar events. In light of the present studies, it seems that these low-value missives continue to circulate not because of their usefulness, but because there is some motivation to share threats as relevant information.

One limitation of these results is that we have no evidence about the boundary conditions for the effects reported. For instance, we used materials in which threat items consisted of potential harm to the body (sprained ankles, burns, etc.). We do not know to what extent the threat-information preference would work in the same manner for other forms of potential danger, e.g., social threats (ostracism, withdrawal of support) or predator-related information. Given that threat-detection systems are highly specific, as they focus on fitness-relevant targets, we should expect differences in the way they motivate the search for information.

Another limitation lies in the fact that our transmission chains were all linear. That is, each "mother" only had one "daughter" and each daughter only one mother. This is a standard aspect of the artificial cultural chains protocols (Miton et al., 2015; Stubbersfield & Tehrani, 2013). But one should be aware of the limitation introduced by this form of idealization. In actual cultural processes, horizontal (within generation) transmission, and inheritance from multiple parents, are the rule rather than the exception, and are often crucial to the stabilization of traditions (Morin, 2016).

Finally, we only considered deliberate selection of information, in contrast to other protocols based on free recall (Miton et al., 2015). This was motivated by the fact that recall is probably not the only crucial factor in cultural transmission. Conversely, the "wear and tear" due to forgetting and misremembering material, may not be as important to cultural change as is often assumed. Morin for instance argues that the extraordinary stability of some traditions, like children's counting rhymes, is due not just to good recall, but to frequent transmission events with multiple teachers and learners, combined with strong incentives for accurate performance (Morin, 2016). Congruent with this argument, we assumed that when people transmit information, e.g., about the benefits and dangers of using a particular product, it is unlikely that people have in fact entirely forgotten the neutral or positive information that they do not convey. Their choice of material is more simply explained by relevance considerations. Still, we cannot definitively rule out memory factors unless we test them alongside deliberate transmission.

In conclusion, these and previous experimental results raise the crucial question, Why do people prefer to share threat information? The studies presented here document this deliberate preference, but do not elucidate motivations for this behavior. Previous studies have shown that sources are perceived to be more competent when they share threat information than when they share non-threatening negative information (Boyer & Parren, 2015). If that is a valid observation, then we would expect some people to convey information about dangers, as to appear competent and therefore valuable contributors to knowledge. But that is unlikely to be the sole factor in the general preference for threat-information. We can assume that preferences for particular kinds of information are best explained by intuitions provided by our evolved threat-detection systems. But the link between threat-detection and information gathering is not well understood so far, and remains a matter for further study.

Ethics statement

The Institutional Review Board at Washington University in St. Louis reviewed and approved all studies included in this article. Before participating in the study, all participants read a description of study procedures, potential risks and benefits (of which there were none), anonymity, and their options to freely opt out. This section also detailed conditions for compensation. After reading this description, all participants indicated their consent to participate using a live button on the survey: "I Agree" or "I Do Not Agree". Individuals could advance only if they selected "I Agree". We collected Amazon Mechanical Turk™ worker ID numbers in order to verify survey completion and compensate participants for their participation. We requested participants' gender, age and ethnicity, but collected no personally identifiable information.

Conflict of interest – financial disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.evolhumbehav.2017.10.001.

References

Allport, G. W., & Postman, L. J. (1947). *The psychology of rumor.* New York: H. Holt and Company.

Altshteyn, I. (2014). *Evidence for a warning bias in information transmission in social networks.* University of California, Los Angeles (Unpublished master's thesis).

Bartlett, F. C. (1932). *Remembering. A study in experimental and social psychology.* Cambridge: Cambridge University Press.

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology*, *5*(4), 323–370. https://doi.org/10.1037/1089-2680.5.4.323.

Bebbington, K., MacLeod, C., Ellison, T. M., & Fay, N. (2017). The sky is falling: Evidence of a negativity bias in the social transmission of information. *Evolution and Human Behavior*, *38*(1), 92–101. https://doi.org/10.1016/j.evolhumbehav.2016.07.004.

Berger, J., & Milkman, K. L. (2012). What makes online content viral? *Journal of Marketing Research*, *49*(2), 192–205. https://doi.org/10.1509/jmr.10.0353.

Bland, J. M., & Altman, D. G. (1998). Survival probabilities (the Kaplan-Meier method). *BMJ*, *317*(7172), 1572–1580. https://doi.org/10.1136/bmj.317.7172.1572.

Bland, J. M., & Altman, D. G. (2004). The logrank test. *BMJ*, *328*(7447), 1073. https://doi.org/10.1136/bmj.328.7447.1073.

Boyd, R., & Richerson, P. J. (1985). *Culture and the evolutionary process.* Chicago: University of Chicago Press.

Boyer, P. (1990). *Tradition as truth and communication: A cognitive description of traditional discourse.* Cambridge: Cambridge Universiy Press.

Boyer, P., & Bergstrom, B. (2011). Threat-detection in child development: An evolutionary perspective. *Neuroscience & Biobehavioral Reviews*, *35*(4), 1034–1041.

Boyer, P., & Parren, N. (2015). Threat-related information suggests competence: A possible factor in the spread of rumors. *PLoS One*, *10*(6), e0128421. https://doi.org/10.1371/journal.pone.0128421.

Boyer, P., & Ramble, C. (2001). Cognitive templates for religious concepts: Cross-cultural evidence for recall of counter-intuitive representations. *Cognitive Science*, *25*, 535–564.

Brunvand, J. H. (1981). *The vanishing hitchhiker: American urban legends and their meanings.* W. W. Norton.

Cosmides, L., & Tooby, J. (2006). Evolutionary psychology, moral heuristics, and the law. In G. Gigerenzer, & C. Engel (Eds.), *Heuristics and the law* (pp. 175–205). Cambridge, MA Berlin US, Germany: MIT Press/Dahlem University Press.

Difonzo, N., & Bordia, P. (2007). *Rumor psychology. Social and organizational approaches.* Washington, DC: American Psychological Association.

Eriksson, K., & Coultas, J. C. (2014). Corpses, maggots, poodles and rats: Emotional selection operating in three phases of cultural transmission of urban legends. *Journal of Cognition and Culture*, *14*(1–2), 1–26.

Fessler, D. M. T., Pisor, A., & Navarrete, C. D. (2014). Negatively-biased credulity and the cultural evolution of beliefs. *PLoS One*, *9*(4), e95167.

Fischhoff, B., Watson, S. R., & Hope, C. (1984). Defining risk. *Policy Sciences*, *17*(2), 123–139.

Goody, J. (1977). *The domestication of the savage mind.* Cambridge: Cambridge University Press.

Haselton, M. G., & Buss, D. M. (2000). Error management theory: A new perspective on biases in cross-sex mind reading. *Journal of Personality and Social Psychology*, *78*(1), 81–91.

Haselton, M. G., & Funder, D. C. (2006). The evolution of accuracy and bias in social judgment. In M. Schaller, J. A. Simpson, & D. T. Kenrick (Eds.), *Evolution and social psychology* (pp. 15–37). Madison, CT, US: Psychosocial Press.

Heath, C. (1996). Do people prefer to pass along good or bad news? Valence and relevance of news as predictors of transmission propensity. *Organizational Behavior and Human Decision Processes*, *68*(2), 79–94. https://doi.org/10.1006/obhd.1996.0091.

Heath, C., Bell, C., & Steinberg, E. (2001). Emotional selection in memes: The case of urban legends. *Journal of Personality and Social Psychology*, *81*(6), 1028–1041.

Hilbig, B. E. (2009). Sad, thus true: Negativity bias in judgments of truth. *Journal of Experimental Social Psychology*, *45*(4), 983–986.

Hilbig, B. E. (2012). How framing statistical statements affects subjective veracity: Validation and application of a multinomial model for judgments of truth. *Cognition*, *125*(1), 37–48.

Ito, T. A., Larsen, J. T., Smith, N. K., & Cacioppo, J. T. (1998). Negative information weighs more heavily on the brain: The negativity bias in evaluative categorizations. *Journal of Personality and Social Psychology*, *75*(4), 887–900.

Maher, K. M., & Van Giffen, K. (1988). Memory for wording and meaning of content-relevant jokes presented in differing arousal conditions. *Psychological Reports*, *63*(3), 899–905. https://doi.org/10.2466/pr0.1988.63.3.899.

Miton, H., Claidière, N., & Mercier, H. (2015). Universal cognitive mechanisms explain the cultural success of bloodletting. *Evolution and Human Behavior*, *36*(4), 303–312. https://doi.org/10.1016/j.evolhumbehav.2015.01.003.

Morin, O. (2013). What does communication contribute to cultural transmission? *Social Anthropology/Anthropologie Sociale*, *21*(2), 230–235. https://doi.org/10.1111/1469-8676.12014.

Morin, O. (2016). *How traditions live and die.* Oxford: Oxford University Press.

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology*, *61*(3), 380–391.

Rozin, P., & Royzman, E. B. (2001). Negativity bias, negativity dominance, and contagion. *Personality and Social Psychology Review*, *5*(4), 296–320. https://doi.org/10.1207/S15327957PSPR0504_2.

Rubin, D. C. (1995). *Memory in oral traditions: The cognitive psychology of epic, ballads, and counting-out rhymes.* New York: Oxford University Press.

Slovic, P. (2016). *The perception of risk.* Taylor & Francis.

Stubbersfield, J., & Tehrani, J. (2013). Expect the unexpected? Testing for minimally counterintuitive (MCI) bias in the transmission of contemporary legends: A computational phylogenetic approach. *Social Science Computer Review*, *31*(1), 90–102. https://doi.org/10.1177/0894439312453567.

Stubbersfield, J. M., Tehrani, J. J., & Flynn, E. G. (2014). Serial killers, spiders and cybersex: Social and survival information bias in the transmission of urban legends. *British Journal of Psychology*. https://doi.org/10.1111/bjop.12073.