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Socially Situated Transmission: The Bias to Transmit Negative Information is Moderated by the Social Context

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Abstract

Cultural evolutionary theory has identified a range of cognitive biases that guide human social learning. Naturalistic and experimental studies indicate transmission biases favoring negative and positive information. To address these conflicting findings, the present study takes a socially situated view of information transmission, which predicts that bias expression will depend on the social context. We report a large-scale experiment ($N = 425$) that manipulated the social context and examined its effect on the transmission of the positive and negative information contained in a narrative text. In each social context, information was progressively lost as it was transmitted from person to person, but negative information survived better than positive information, supporting a negative transmission bias. Importantly, the negative transmission bias was moderated by the social context: Higher social connectivity weakened the bias to transmit negative information, supporting a socially situated account of information transmission. Our findings indicate that our evolved cognitive preferences can be moderated by our social goals.

Keywords: Cultural evolution; Social transmission; Transmission fidelity; Cognitive bias; Negativity bias; Positivity bias; Situated cognition; Socially situated cognition

1. Introduction

Whether gossiping with a friend or sharing a restaurant recommendation on social media, information sharing is a ubiquitous human activity (Dunbar, 2004). Acquiring information socially can be adaptive, especially when it avoids otherwise costly individual learning (Laland, 2004). Information sharing is frequent and important, but little is known about why

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certain information is shared, or how this might be affected by the social context (Berger & Milkman, 2012). There is some evidence that negative information is shared more than positive information (e.g., Bebbington, MacLeod, Ellison, & Fay, 2017), but this is contentious with other studies showing that positive information is shared more than negative information (e.g., van Leeuwen, Parren, Miton, & Boyer, 2018). The present study addresses this discrepancy by demonstrating that the social context can moderate the type of information that people share.

Cultural evolutionary theory has identified a range of evolved cognitive preferences, or biases, that guide human social learning (Boyd & Richerson, 1985; Sperber, 1996). These can be broadly categorized as content- or context-dependent social learning strategies (Henrich & McElreath, 2003; Kendal et al., 2018). Content-dependent strategies rely on a direct assessment of the intrinsic value of the information. By contrast, context-dependent strategies rely on indirect indicators, such as the characteristics of the model communicating the information (e.g., their prestige; Chudek, Heller, Birch, & Henrich, 2012) or the number of people endorsing the information (e.g., majority bias; Asch, 1951; Haun, Rekers, & Tomasello, 2012; Lewandowsky, Cook, Fay, & Gignac, 2019). The present paper is concerned with content bias: how the characteristics of the information affect its transmission. A range of content biases have been identified, including a preference to share information that is effective (Fay, Walker, Swoboda, & Garrod, 2018), novel (Vosoughi, Roy, & Aral, 2018), social (Mesoudi, Whiten, & Dunbar, 2006), survival-related (Nairne, Pandeirada, & Thompson, 2008; Stubbersfield, Tehrani, & Flynn, 2015), or stereotype-consistent (Kashima, 2000).

Theorists have argued for a general bias toward negative entities (e.g., events, objects, personal traits) on the basis that avoiding danger (e.g., a predator) has a greater impact on fitness than pursuing rewards (e.g., a nutritious food source; Rozin & Royzman, 2001). This evolutionary account suggests that negative content is more *informative* than positive content and is thus more valuable. Similarly, information value has been used to explain the survival of rumors and urban legends (Allport & Postman, 1947; Brunvand, 1981; Heath, Bell, & Sternberg, 2001). The existence of a general negativity bias is supported by naturalistic and experimental studies. For example, 2018 news reports contained a higher incidence of negative content, compared to positive content (Acerbi, 2019); in 20th-century literary fiction, the frequency of positive emotion terms decreased, whereas the frequency of negative emotion terms did not (Morin & Acerbi, 2017), and for song lyrics (sampled between 1965 and 2015), there was a decrease in positive emotion words and an increase in negative emotion words (Brand, Acerbi, & Mesoudi, 2019). Experimental studies have shown that, compared to positive information, negative information has a greater impact on impression formation (Peeters & Czapinski, 1990) and is more believable (Fessler, Pisor, & Navarrete, 2014). Furthermore, experimental studies of the propagation of information in social networks—using the method of serial reproduction (Bartlett, 1932) in which information is passed from person to person across a transmission chain—have demonstrated the preferential transmission of negative information. This has been shown for threat-related information (Blaine & Boyer, 2018), risk-related information (Jagiello & Hills, 2018; Moussaïd et al., 2015), disgust-related information (Eriksson & Coultas, 2012), and for negative events more generally (Bebbington et al., 2017).

However, support for a general negative transmission bias is not universal. In fact, several studies have demonstrated a positive transmission bias. For example, positive articles in the New York Times were shared more often than negative articles (Berger & Milkman, 2012). In one experimental study, participants chose to transmit positive low-arousal vignettes more often than negative high-arousal vignettes (van Leeuwen et al., 2018), and in another study, participants chose to transmit morally good content more often than neutral or morally bad content (Stubbersfield, Dean, Sheikh, Laland, & Cross, 2019). This positive transmission bias can be explained by appealing to *social connectivity* rather than *informativeness*: People may prefer to transmit upbeat positive information because it fosters a positive impression and improves the social bond between people. Consistent with this explanation, a preference for social connectivity over informativeness was demonstrated in a study on the social transmission of stereotype information (A. E. Clark & Kashima, 2007). Here, participants preferentially transmitted stereotype-consistent information when the stereotype was shared with their target audience. That is, participants prioritized transmitting shared information that enhanced their social bond over stereotype-inconsistent information that was unshared and more informative (also see Stasser & Titus, 1985).

To address these opposing findings, the present study takes a socially situated view of human cognition (A. Clark, 1998; Smith & Semin, 2007). On this view, cognition is not restricted to internal processes but is situated within and modulated by the social context. In the context of information transmission, the type of information that people choose to transmit will depend on the goal of social transmission, which itself depends on the context in which it occurs. Bebbington et al. (2017) demonstrated a bias to transmit negative information in an experiment where participants were informed that the function of transmission was to be optimally informative. This was reinforced by the context, which involved the individual reproduction of a narrative text without any knowledge of the intended audience. The context for information transmission in the Berger and Milkman (2012) study, which found a bias toward sharing positive information, was very different. Here, the context involved the transmission of information between people who had a shared history. In this context, we can infer that the function of social transmission was to be both informative and socially connective (i.e., to regulate the social relationship).

In the study reported, we experimentally manipulated the social context and examined its effect on the valence of the content (i.e., positive or negative) participants chose to transmit. A transmission chain design was used to allow us to track the survival of positive and negative information as it was repeatedly transmitted. Participants read a narrative text that contained a range of positive and negative events, plus ambiguous events that could be positively or negatively resolved (from Bebbington et al., 2017). Social connectivity was varied over four contexts: two asocial contexts and two social contexts (with a low or high level of social connectivity). In both asocial contexts, participants were instructed to reproduce the narrative text. In one asocial context, each participant reproduced the narrative text four times (repeated reproduction context), and in the other asocial context, each participant reproduced the narrative text once within a four-person transmission chain (reproduction intent context). The asocial contexts are analogous to personal note-taking. In both social contexts, participants were organized in four-person transmission chains and instructed to communicate the narrative text. In one social context, each participant communicated the narrative text to another (absent) person (communication intent context). This context, analogous to writing a letter or email, simulates a low level of social connectivity. Unlike the other three contexts, in which information transmission was uni-directional (i.e., from sender to receiver), in the second social context, information transmission was bi-directional, with participants interactively communicating the narrative text to a co-present partner (social interaction context). This social context, analogous to a dyadic conversation, simulates a high level of social connectivity. Furthermore, it simulates a common setting for information exchange that is absent in standard transmission chain studies (in part due to the logistical challenges it poses), despite calls to include this essential property of the communication process (Pelletier & Drozda-Senkowska, 2020).

We predict that information will be progressively lost as it is passed from person to person, as is typical in transmission chain studies (Bartlett, 1932; Tan & Fay, 2011; although see Fay et al., 2018). Following Bebbington et al. (2017), we predict a negative transmission bias: Negative event information will be transmitted more often than positive event information, and ambiguous event information will more often be transformed negatively than positively. Our key prediction is that the negative transmission bias will be moderated by the social context, such that the bias to transmit negative information will be weakened as social connectivity is increased (potentially giving rise to a positive transmission bias in the social contexts). The negative transmission bias is likely to be weakest in the context with the highest level of social connectivity (i.e., the social interaction context).

2. Method

The study received approval from the University of Western Australia Ethics Committee. Participants completed the task as part of a teaching activity. Participants chose whether or not their data could be used for research purposes. All methods were performed in accordance with the guidelines from the National Health and Medical Research Council/Australian Research Council/University Australia's National Statement on Ethical Conduct in Human Research.

2.1. Participants

A convenience sample of 479 undergraduate psychology students from the University of Western Australia participated in exchange for partial course credit. Of these, 425 participants (307 female, 114 male, 4 non-binary and unspecified) agreed to their data being used for research purposes. These participants ranged in age from 18 to 60 years ($M = 21.50$, $SD = 6.91$).

2.2. Materials

The present study used the story developed by Bebbington et al. (2017). The story concerned a young girl who was traveling from Australia to the United Kingdom. It described

57 events that occurred during her journey. Each event was described in a single statement. Of the total events, eight were unambiguously positive (e.g., “When [the flight attendant] returned she told Sarah that she would be moved to business class”) and eight were unambiguously negative (e.g., “The man in the seat next to her seemed to have a nasty cold”). The story also included eight ambiguous events that could be interpreted positively or negatively (e.g., “Walking down the concourse, Sarah saw a young man take an old woman’s bag,” which could be interpreted to mean that the young man stole the woman’s bag [negative] or that the young man helped the old woman carry her bag [positive]). Thirty-three filler events were included that were neutral with regard to valence and were used to connect the negative, positive, and ambiguous events in the story (e.g., “On the day of her trip Sarah arrived at the airport”). Although relatively mundane, the story was designed to simulate everyday social exchange (Dunbar, 2004). The complete story is available in Supplementary Materials 1.

Using independent judges, Bebbington et al. (2017) confirmed the intended valence of the unambiguously positive and negative events and that the ambiguous events could be interpreted as either positive or negative. There was a concern that the positive and negative events from Bebbington et al. (2017) may not be comparable in terms of their degree of positivity/negativity. For example, the valence of the negative events may have been more extreme than the valence of the positive events. To assess this, we recruited 55 naïve participants to rate the valence of each positive and negative event (from –50 to 50). As per Bebbington et al. (2017), the positive events were rated as positive on average ($M = 34.39$, $SD = 15.30$), and the negative events were rated as negative on average ($M = -32.81$, $SD = 15.67$). The negative event ratings were then reverse-coded and compared to the positive event ratings. There was no statistical evidence of a difference in the rated extremity of the positive and negative events ($p = .721$; see Supplementary Materials 2). So the positive and negative events were deemed to be comparable.

2.3. Design and procedure

The study used a 4 × 2 × 4 experimental design, with social context (repeated reproduction, reproduction intent, communication intent, social interaction) as a between-participants factor and event valence (positive, negative) and chain position (1–4) as within-participants factors.1. Participants were randomly allocated to transmission chains. Each chain was pre-allocated to one of the four social contexts. The social context was manipulated to vary social connectivity, ranging from an asocial context in which participants repeatedly transmitted the narrative text for themselves (repeated reproduction) to a social context in which they interactively communicated the narrative to a co-present partner (social interaction). For the repeated reproduction context, one participant filled all four chain positions. For the other contexts, each participant was randomly allocated to one of the four chain positions.

In the repeated reproduction context, participants were told they would be presented with some verbal information in the form of a short story, which they would later “reproduce four separate times.” This intra-individual context allowed us to determine the degree to which participants exhibited a cognitive bias toward negative or positive content. This condition also served as a baseline against which the interpersonal transmission conditions could be compared. In the reproduction intent context participants were instructed to "reproduce" the story. Their transmitted story was then passed to the next person in their chain to read and later transmit. This inter-individual context allowed us to determine the extent to which the content transmitted was affected by interpersonal transmission. In the communication intent context participants were instructed to read the story then "communicate it to another person." By adding communication intent, this context increased social connectivity (low social connectivity), allowing us to determine its effect on the content transmitted. In the social interaction context participants were told that they would have a conversation with a partner using a text-chat interface. Their partner would describe a short story, and they would later communicate the story to another person in a second text-chat conversation. Allowing participants to directly interact with a partner boosted social connectivity (high social connectivity), allowing us to test its effect on the content transmitted. In each context, the story was transmitted by typing it into the computer interface. In the social interaction context, the interface allowed participants to directly interact with the adjacent participants in their chain, in a manner similar to a standard text-chat interface.

At chain position 1, all participants received the same original story. At Chain Positions 2–4 (excluding the repeated reproduction context), participants read the story produced by the person in the prior chain position. In the repeated reproduction and the reproduction intent contexts, participants were instructed to "read through the story carefully, so that you can reproduce it later." In the communication intent context, participants were instructed to "read through the story carefully, so that you can communicate it later." In these contexts, participants were given 165 s to read the story (as per Bebbington et al., 2017). In the social interaction context, participants allocated to Chain Position 1 read the story as per the communication intent context. Participants allocated to Chain Positions 2–4 in the social interaction context received the story in a text-chat conversation with the previous participant in their chain. They were told to "try to understand the story, so that you can communicate it later," and that "although your partner will be telling the story, this is a conversation— you may also talk to them." Participants were given 10 min to have their text-chat conversation (to match the time limit for typing the story in the other social contexts). In all contexts, a progress bar was shown below the story/conversation to indicate the remaining time.

After reading the story, and prior to producing the story, participants completed the 6-item versions of two State-Trait Anxiety Inventory subscales (Fioravanti-Bastos, Cheniaux, & Landeira-Fernandez, 2011; Marteau & Bekker, 1992). The state inventory assessed current anxiety, and the trait inventory assessed general anxiety. The subscales were included as a distractor task. Next, participants typed the story. In the repeated reproduction and reproduction intent contexts, participants were instructed to "reproduce the story you read earlier." Participants in the communication intent context were instructed to "communicate the story you read earlier. You are communicating the story to another person." Participants in the social interaction context were told that they would be having a conversation with another person. They were instructed to "communicate the story you read earlier," and that "although you will be telling the story, this is a conversation—your partner may also talk to you." All participants were given 10 min to type the story (as per Bebbington et al., 2017), and a progress bar was shown below the story-input box/conversation to indicate the remaining time. If participants finished typing the story before the 10 min had elapsed, they could click a button to submit the story early. (In the social interaction context, both participants in the conversation had to click this button to end the conversation.) The experiment ended here, except for participants in the repeated reproduction context. Participants in the repeated reproduction context proceeded to the distractor task again, before writing the story again; after cycling through and typing the story four times in total, the experiment ended. The complete set of instructions for each social context is given in Supplementary Materials 3.

3. Results

All measures, manipulations, and exclusions in the study are reported. The sample size was determined before any data analysis and was based on Bebbington et al. (2017). The data were analyzed using logistic mixed effects modeling, with crossed random effects for chains and events. All analyses were performed and all figures were created in R (R Core Team, 2013). No additional data was collected after data analysis. Figures were created using ggplot2, and statistical models were estimated using the glmer() function of lme4 (Bates et al., 2019). The maximal random effects structure justified by the experiment design was specified where possible (Barr, Levy, Scheepers, & Tily, 2013).

The materials, data, and R Script associated with this study are available on the Open Science Framework: https://osf.io/2uf8j/?view_only=a4613d4e19424509a2a48517aad576b9

3.1. Transmission of positive and negative events

A coder, blind to the experimental manipulations, assessed each story transmission and coded if each positive and negative event present in the original story was retained. An event was coded as present if the basic gist was considered to be the same as an event in the original story. A second coder (BW) coded a random selection of 20% of the transmitted stories using the same procedure. Inter-coder reliability was high (Krippendorff's alpha = .897). The first coder's assessment was used in the analysis. Positive and negative event survival (coded as a 1 or 0) was analyzed using logistic mixed effects modeling. Social context, valence, and chain position (each centred) were entered as fixed effects. Event position (story event 3 to 53) was included as a fixed effect (linear and quadratic) to control for the influence of event position on the transmission of positive and negative events, including a serial position effect (i.e., a recall benefit for early or late events; Murdock Jr., 1962). The random-effects structure included by-chain and by-event random intercepts. When possible, by-chain random slopes for valence were included (this was the maximal model that would converge; see Supplementary Materials 4 for each model specification and all statistical output). The experimental social contexts were compared in a pairwise fashion (see Fig. 1a).

First, we compared the repeated reproduction and reproduction intent contexts. The best-fitting model specified social context and valence as fixed effects ($\beta = -0.97$, $SE = 0.28$, $z = -3.45$, $p < .001$; $\beta = -1.58$, $SE = 0.54$, $z = -2.95$, $p = .003$), and a social context by chain position interaction ($\beta = -0.31$, $SE = 0.07$, $z = -4.52$, $p < .001$). The effect of

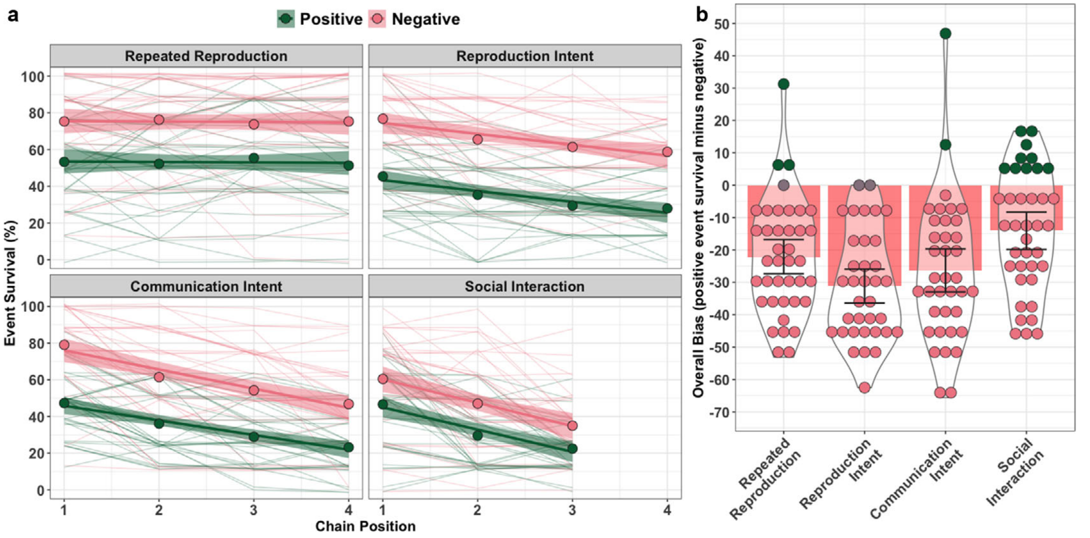

Fig 1. (a) Change in the survival of positive and negative event information across chain positions for each social context (expressed as percentages and plotted for each transmission chain). A small amount of noise was added to the scores to avoid over-plotting. The dot points indicate the overall mean at each chain position. The straight lines (positive in green and negative in pink) are the linear model fits and the shaded areas are the 95% CIs. Only chain positions 1–3 are shown for the social interaction context. This is because at chain position 4 participants did not have a partner to interact with. (b) The mean bias score (positive, negative) for each social context (positive information survival minus negative information survival, collapsed across chain positions 1–3). The colored bars indicate the mean bias score for each social context, and the dot points indicate the mean bias score for each chain. Green dot points indicate a positive transmission bias (> 0), gray dot points indicate no bias ($= 0$), and pink dot points indicate a negative transmission bias (< 0). The violins provide distributional information, and the error bars are the 95% CIs.

social context indicates that information was transmitted with higher fidelity in the repeated reproduction context. The effect of valence indicates that, in both contexts, negative information survived better than positive information. The social context by chain position interaction reflects the stable recall of information (after an initial loss relative to the original story) in the repeated reproduction context ($p = .564$), and the consistent loss of information across chain positions in the reproduction intent context ($\beta = -0.34$, $SE = 0.05$, $z = -6.84$, $p < .001$).

Next, we compared the reproduction intent and communication intent contexts. The best-fitting model specified valence as a fixed effect ($\beta = -1.58$, $SE = 0.58$, $z = -2.70$, $p = .007$), and a social context by chain position interaction ($\beta = 0.23$, $SE = 0.07$, $z = 3.35$, $p < .001$). Again, the effect of valence indicates that, in both contexts, negative information survived better than positive information. The social context by chain position interaction reflects the higher transmission fidelity of events across chain positions in the reproduction intent context ($\beta = -0.34$), compared to the communication intent context ($\beta = -0.54$, $SE = 0.05$, $z = -11.39$, $p < .001$).

Finally, we compared the communication intent and social interaction contexts. Only chain positions 1 to 3 were included in the analysis. This is because, in the social interaction context, at chain position 4 participants did not have a partner to interact with. The best-fitting model specified social context, valence and chain position as fixed effects ($\beta = -0.65$, $SE = 0.21$, $z = -3.11$, $p = .002$; $\beta = -1.10$, $SE = 0.61$, $z = -1.79$, $p = .074$; $\beta = -0.70$, $SE = 0.05$, $z = -13.07$, $p < .001$), and a social context by valence interaction ($\beta = 0.66$, $SE = 0.17$, $z = 3.87$, $p < .001$). The effect of social context indicates that information was transmitted with higher fidelity in the communication intent context. Again, the effect of valence indicates that, in both contexts, negative information survived better than positive information. The effect of chain position indicates that, in both contexts, information was lost as it was passed from person to person. The social context by valence interaction is explained by the differential survival of positive and negative events across contexts: Positive events survived equally well across contexts ($p = .173$), but negative events survived better in the communication intent context, compared to the social interaction context ($\beta = -1.03$, $SE = 0.27$, $z = -3.78$, $p < .001$).

In summary, our findings support a bias for negative information: In all social contexts, negative event information survived better than positive event information. Transmission fidelity was moderated by the social context. Specifically, transmission fidelity: (a) was highest when individual participants repeatedly transmitted the information (repeated reproduction), (b) decreased as information was passed from person to person (all inter-individual contexts), and (c) decreased as social connectivity increased (i.e., included communication intent and social interaction). As predicted by a social connectivity account, social interaction attenuated the bias to transmit negative information (see Fig. 1b).

3.2. Survival, loss, and transformation of ambiguous events

A coder, blind to the experimental manipulations, assessed each story reproduction and coded if each originally ambiguous story event had survived as ambiguous or had been transformed into a positive or negative event. As before, a second coder (BW) coded a random selection of 20% of the transmitted stories using the same procedure. Inter-coder reliability was high (Krippendorff's alpha = .822). The first coder's assessment was used in the analysis.

Fig. 2a illustrates the survival (remained ambiguous), loss (lost), and transformation (transformed) of the ambiguous events over chain positions for each social context. In the repeated reproduction context, the proportions did not change over chain positions. In the inter-individual contexts, the proportion of events that were lost increased over chain positions (50.69% at chain position 1 and 72.69% at chain position 4), the percentage that remained ambiguous decreased over chain positions (28.21% at chain position 1 and 6.15% at chain position 4) and the percentage that were transformed remained stable over chain positions (21.26% at chain position 1 and 20.27% at chain position 4). The latter finding indicates that once transformed, the events were transmitted with high fidelity. Fig. 2b highlights the tendency for ambiguous information to be lost (58.91%) and the relatively infrequent tendency for ambiguous information to remain ambiguous (20.56%) or be transformed (20.53%).

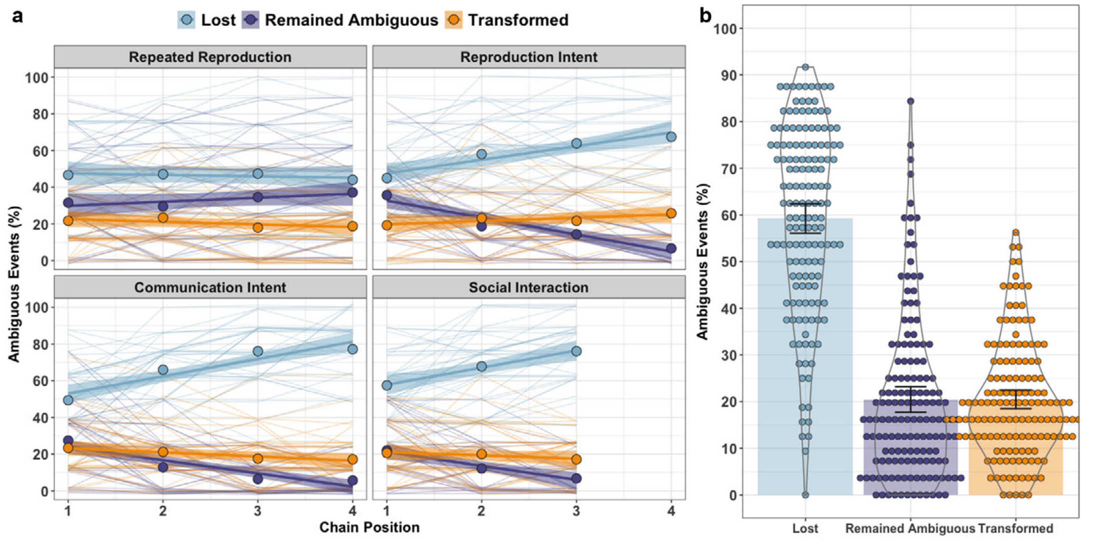

Fig 2. (a) Change in the survival (remained ambiguous, in purple), loss (lost, in light blue), and transformation (transformed, in orange) of ambiguous events across chain positions for each social context (expressed as percentages and plotted for each transmission chain). A small amount of noise was added to the scores to avoid over-plotting. The straight lines are the linear model fits and the shaded areas are the 95% CIs. (b) The mean percentage of events that were lost (in light blue), remained ambiguous (in purple), or were transformed (in orange), collapsed across social contexts and chain positions. The dot points indicate the mean percentage score for each chain. The violins provide distributional information and the error bars are the 95% CIs.

3.3. Transformation of ambiguous events to positive or negative events

The transformation of ambiguous events into positive or negative events was infrequent, so the data was collapsed across chain positions for the purpose of analysis. Because some participants did not agree to their data being used for research purposes, 10 chains had missing data at chain positions 1–3. These chains were excluded from the analysis. A further eight chains had data missing at chain position 4 (not including the social interaction social context, which only returned data across chain positions 1–3). Rather than exclude these chains from the analysis, we instead limited the analysis for all social contexts to chain positions 1–3. This allowed us to compare across the four social contexts in a single analysis (as each social context now included data for chain positions 1–3 only). For each ambiguous event, we determined if it was transformed positively (1 or 0) or negatively (1 or 0). This approach left open the possibility that the event was neither positively nor negatively transformed. The data were analyzed using a logistic mixed effects model. Social context (factor coded) and valence (centered) were entered as fixed effects. The random effects structure included by-event random intercepts. This was the maximal model that would converge (see Supplementary Materials 4 for the model specification and all statistical output).

The best-fitting model specified valence as a fixed effect ($\beta = 0.43$, $SE = 0.12$, $z = 3.75$, $p < .001$). There was no statistical evidence of a difference between the social contexts ($ps > .660$), or of a social context by valence interaction ($ps > .149$). Our findings again

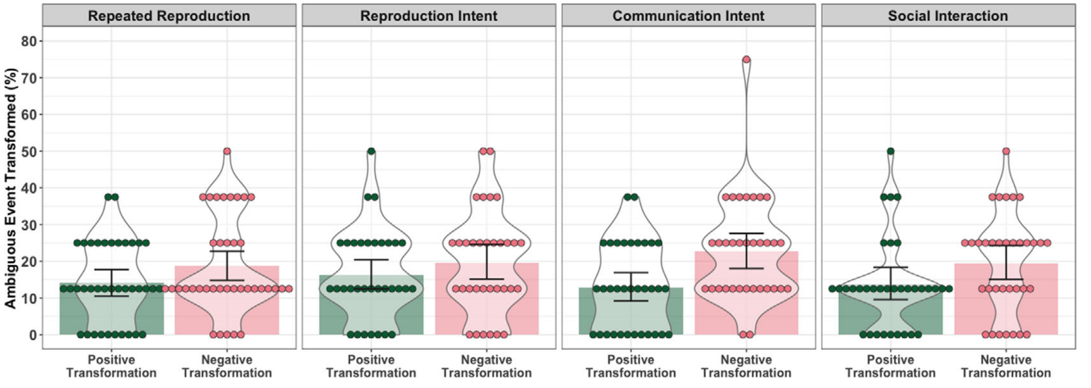

Fig 3. Positive and negative transformation of the ambiguous events (expressed as a percentage of total ambiguous events, collapsed across chain positions) for each social context. The colored bars indicate the overall mean for each type of transformation (positive in green and negative in pink) and the dot points indicate the mean for each chain. The violins provide distributional information, and the error bars are the 95% CIs.

support a bias for negative information: In each social context, when the ambiguous events were transformed, they were transformed negatively more often than positively. Our findings do not support a social connectivity account; there was no statistical evidence that ambiguous event transformation was affected by the social context (see Fig. 3).

4. Discussion

The extent to which cultural transmission is characterized by a bias to transmit negative or positive information is contentious. While negative information may be more *informative* than positive information, positive information may be more *socially connective* than negative information. The present study took a socially situated view of information transmission, predicting that what people choose to transmit will depend on the social context. Using a large-scale experiment ($N = 425$), we manipulated the social context and examined its effect on the content (positive, negative) people transmitted.

When a single person was instructed to repeatedly *reproduce* the narrative text (repeated reproduction context) negative information was transmitted more often than positive information. This finding is consistent with an individual-level bias for negative information. Following the same instructions, but using a four-person transmission chain design (reproduction intent context), information was incrementally lost as it was passed from person to person as is typical in serial reproduction studies (Bartlett, 1932; Tan & Fay, 2011). Despite this information loss, negative information was transmitted more often than positive information, replicating the inter-individual negative transmission bias identified by Bebbington et al. (2017). Social connectivity was increased by adding communicative intent to the next two social contexts. Participants, again organized into four-person transmission chains, were instructed to *communicate* the narrative text to the next person in the chain (communicative intent context, low social connectivity). This reduced the quantity of information transmitted (positive and negative), suggesting that increasing social connectivity led to greater information curation (relative to the reproduction intent context). However, it did not weaken the bias to transmit negative information; despite the greater overall loss of information, negative information was again transmitted more often than positive information (similar to the asocial reproduction intent context). In our maximally socially connective context, participants could directly interact with their audience during information transmission (social interaction context, high social connectivity). Here, the transmission of positive information was comparable to the communicative intent context, but negative information was more heavily filtered. While participants still showed a preference to transmit negative information, the negative transmission bias in this context was weaker, indicating that greater social connectivity attenuated the bias to transmit negative information. Taken together, our findings indicate that increasing social connectivity can attenuate the bias to transmit negative information, but this was only observed under high social connectivity. This finding suggests a qualitative difference between uni-directional message design and bi-directional conversational exchange (also see Fay et al., 2018).

The narrative text also contained ambiguous events that could be interpreted as positive or negative, and then transmitted as unambiguously positive or unambiguously negative events. This transformative process is in the spirit of cultural attraction theory (Sperber, 1996; see Acerbi & Mesoudi, 2015 for a discussion of Darwinian cultural evolutionary theory and cultural attraction theory). Here, the different social contexts showed similarly strong biases to transform the ambiguous events into negative events (rather than positive events). Contrary to a socially situated account, the negative disambiguation of events was not moderated by the social context. One explanation for this null effect is that while there was sufficient statistical power to detect a main effect of event valence, there may have been insufficient statistical power to detect an interaction between valence and social context (Blake & Gangestad, 2020). This is likely to have been compounded by the sparsity of the data (the majority of the eight ambiguous events were lost or remained ambiguous; only 20.53% or 1.64 of the initial eight ambiguous events were resolved). Alternatively, it is possible that the resolution of ambiguous events is driven by an internal encoding process (i.e., an interpretation bias; Wilson et al., 2006) that is not amenable to social modulation, and therefore disambiguation is unaffected by the social context. This should be pursued in future research.

In the context of a single experiment, a particular experimental paradigm and a specific narrative text, the present study supports a bias for negative information; unambiguously negative events were transmitted more often than positive events, and ambiguous events were transformed to negative events more often than positive events. As predicted by a socially situated explanation of information transmission, the social context affected what information was transmitted; greater social connectivity was found to attenuate the bias to transmit (unambiguously) negative information. This finding, that cognitive bias expression was moderated by the social context, may help reconcile the finding of positive and negative transmission biases in the literature. Perhaps increasing social connectivity further (e.g., face-to-face communication among friends) would return a positive transmission bias. Our findings also demonstrate that cognitive biases are not invariant; they can adapt to the social goals of the person transmitting the information (also see Fay et al., 2018). Similar to the situation-specific use of stereotypes (Blair, 2002; A. E. Clark & Kashima, 2007) and language (Nölle, Fusaroli, Mills, & Tylén, 2020; Winters, Kirby, & Smith, 2015) and the general tendency for communicators to tailor their message to their audience (Bell, 1984; H. H. Clark & Murphy, 1982), our findings highlight the impact of the social context on information transmission.

4.1. Limitations and implications for misinformation and online information sharing

A potential limitation of the study reported, which relied on text-based information exchange, is the extent to which our findings might generalize to spoken information exchange. In response, we point to text-chat studies that replicate the results returned by spoken referential communication studies: In both modalities, perspective-taking is a common message-design strategy (Rogers & Fay, 2016; Schober, 1993), and, over recurring social interactions, communication success improves and referring expressions become increasingly succinct and efficient (H. H. Clark & Wilkes-Gibbs, 1986; Micklos, Walker, & Fay, 2020). Even if our findings do not generalize to spoken information exchange, written information exchange is common, and the findings are directly relevant to communication via text message on mobile phones (which people prefer over voice calls; Walsh, White, & Young, 2010) and our increasing reliance on text-based communication in social media. Another potential limitation is that the negative transmission bias observed in our study may be driven by characteristics of the events other than their negativity, such as their salience (Schelling, 1960) or the emotions they elicit (Lerner & Keltner, 2000). Of course, these characteristics may be inherent to and inseparable from negative information. Future research should investigate the mechanisms driving the negativity bias.

Our findings have implications for the etiology of false information (e.g., false rumors and misinformation) and its spread. This is especially important given concerns around the proliferation of false information online and evidence indicating that once false information is accepted it is difficult to correct (Walter & Tukachinsky, 2020). A consistent pattern returned by transmission chain studies is that person-to-person information transmission is characterized by information loss and transformation (e.g., Bartlett, 1932), giving rise to the spread of misinformation. This was confirmed by the present study, which demonstrated the progressive loss of information in the inter-individual contexts, the preferential transmission of negative content and the negatively biased transformation of ambiguous information. Thus, social transmission can distort the information environment. Our findings therefore illustrate that false or misleading information can be an unintentional outcome of person-to-person information transmission. While social media platforms, such as Facebook and Twitter, have the potential to eliminate information loss and transformation via their high fidelity information re-sharing functionality, this same functionality can also accelerate the spread of false information (Vosoughi et al., 2018).

Our key finding, that social connectivity moderated the sharing of positive and negative information, can help explain the content people share online. Crockett (2017) observed that information regarding a moral norm violation was shared more online than offline. The sharing of moral outrage may thrive online for various reasons, including the greater ease of transmission and the avoidance of risk from the wrongdoer. Another reason, suggested by the present study, is that lower social connectivity between people on social media (i.e., people separated geographically, who may never interact face-to-face) may encourage the sharing of negative information online.

5. Conclusion

The literature has identified a bias to transmit negative information and a bias to transmit positive information. Consistent with a socially situated view of information transmission, the present study experimentally demonstrated that the content people choose to transmit is moderated by the social context; while each context tested showed a bias to transmit negative information (relative to positive information), higher person-to-person social connectivity was found to attenuate the negative transmission bias. At the basic level, our findings indicate that cognitive biases are not invariant; they can adapt to the social goals of the person transmitting the information. At an applied level, our findings suggest that misinformation is a likely outcome of the information loss and transformation that is characteristic of person-to-person information transmission and that negative information may prosper online due to lower interpersonal social connectivity.

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Notes

1. Chain position was treated as a within-participants factor in all social contexts because within each chain, participants' behavior was non-independent. For example, the behavior of participants in chain position 2 was contingent upon the behavior of participants in chain position 1 (who provided the input they read and later transmitted).

References

Acerbi, A. (2019). Cognitive attraction and online misinformation. *Palgrave Communications*, *5*(1), 15. https://doi.org/10.1057/s41599-019-0224-y

Acerbi, A., & Mesoudi, A. (2015). If we are all cultural Darwinians what's the fuss about? Clarifying recent disagreements in the field of cultural evolution. *Biology & Philosophy*, *30*(4), 481–503. https://doi.org/10.1007/s10539-015-9490-2

Allport, G. W., & Postman, L. F. (1947). *The psychology of rumor*. New York: Russell & Russell.

Asch, S. E. (1951). Effects of group pressure upon the modification and distortion of judgments. In H. Guetzkow (Ed.), *Groups, leadership, and men: Research in human relations* (pp. 177–190). Pittsburgh: Carnegie Press.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*(3), 255–278. https://doi.org/10.1016/j.jml.2012.11.001

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

Bates, D., Maechler, M., Bolker, B., Walker, S., Christensen, R. H. B., Singmann, H., Dai, B., Scheipl, F., Grothendieck, G., Green, P., Fox, J., Bauer, A., & Krivitsky, P. N. (2019). *lme4: Linear mixed-effects models using "Eigen" and S4* (1.1-21) [Computer software]. Available at: https://CRAN.R-project.org/package=lme4

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

Bell, A. (1984). Language style as audience design. *Language in Society*, *13*(2), 145–204. https://doi.org/10.2307/4167516

Berger, J., & Milkman, K. L. (2012). What makes online content viral? *Journal of Marketing Research*, *49*(2), 192–205.

Blaine, T., & Boyer, P. (2018). Origins of sinister rumors: A preference for threat-related material in the supply and demand of information. *Evolution and Human Behavior*, *39*(1), 67–75. https://doi.org/10.1016/j.evolhumbehav.2017.10.001

Blair, I. V. (2002). The malleability of automatic stereotypes and prejudice. *Personality and Social Psychology Review*, *6*(3), 242–261.

Blake, K. R., & Gangestad, S. (2020). On attenuated interactions, measurement error, and statistical power: Guidelines for social and personality psychologists. *Personality and Social Psychology Bulletin*, *46*(12), 1702–1711. https://doi.org/10.1177/0146167220913363

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

Brand, C. O., Acerbi, A., & Mesoudi, A. (2019). Cultural evolution of emotional expression in 50 years of song lyrics. *Evolutionary Human Sciences*, *1*, e11. https://doi.org/10.1017/ehs.2019.11

Brunvand, J. H. (1981). *The vanishing hitchhiker: American urban legends and their meanings*. New York: WW Norton & Company.

Chudek, M., Heller, S., Birch, S., & Henrich, J. (2012). Prestige-biased cultural learning: Bystander's differential attention to potential models influences children's learning. *Evolution and Human Behavior*, *33*(1), 46–56.

Clark, A. (1998). *Being there: Putting Brain, body, and world together again*. Cambridge, MA: MIT Press.

Clark, A. E., & Kashima, Y. (2007). Stereotypes help people connect with others in the community: A situated functional analysis of the stereotype consistency bias in communication. *Journal of Personality and Social Psychology*, *93*(6), 1028.

Clark, H. H., & Murphy, G. L. (1982). Audience design in meaning and reference. *Advances in Psychology*, *9*, 287–299.

Clark, H. H., & Wilkes-Gibbs, D. (1986). Referring as a collaborative process. *Cognition*, *22*, 1–39.

Crockett, M. J. (2017). Moral outrage in the digital age. *Nature Human Behaviour*, *1*(11), 769. https://doi.org/10.1038/s41562-017-0213-3

Dunbar, R. I. M. (2004). Gossip in evolutionary perspective. *Review of General Psychology*, *8*(2), 100–110. https://doi.org/10.1037/1089-2680.8.2.100

Eriksson, K., & Coultas, J. C. (2012). The advantage of multiple cultural parents in the cultural transmission of stories. *Evolution and Human Behavior*, https://doi.org/10.1016/j.evolhumbehav.2011.10.002

Fay, N., Ellison, T. M., Tylén, K., Fusaroli, R., Walker, B., & Garrod, S. (2018). Applying the cultural ratchet to a social artefact: The cumulative cultural evolution of a language game. *Evolution and Human Behavior*, *39*(3), 300–309. https://doi.org/10.1016/j.evolhumbehav.2018.02.002

Fay, N., Walker, B., Swoboda, N., & Garrod, S. (2018). How to create shared symbols. *Cognitive Science*, *42*(S1), 241–269. https://doi.org/10.1111/cogs.12600

Fessler, D. M. T., Pisor, A. C., & Navarrete, C. D. (2014). Negatively-biased credulity and the cultural evolution of beliefs. *PLoS ONE*, *9*(4), e95167. https://doi.org/10.1371/journal.pone.0095167

Fioravanti-Bastos, A. C. M., Cheniaux, E., & Landeira-Fernandez, J. (2011). Development and validation of a short-form version of the Brazilian state-trait anxiety inventory. *Psicologia: Reflexão e Crítica*, *24*(3), 485–494.

Haun, D. M., Rekers, Y., & Tomasello, M. (2012). Majority-biased transmission in chimpanzees and human children, but not orangutans. *Current Biology : CB*, *22*(8), 727–731.

Heath, C., Bell, C., & Sternberg, E. (2001). Emotional selection in memes: The case of urban legends. *Journal of Personality and Social Psychology*, *81*(6), 1028–1041. https://doi.org/10.1037/0022-3514.81.6.1028

Henrich, J., & McElreath, R. (2003). The evolution of cultural evolution. *Evolutionary Anthropology: Issues, News, and Reviews*, *12*(3), 123–135.

Jagiello, R. D., & Hills, T. T. (2018). Bad news has wings: Dread risk mediates social amplification in risk communication. *Risk Analysis*, *38*(10), 2193–2207. https://doi.org/10.1111/risa.13117

Kashima, Y. (2000). Maintaining cultural stereotypes in the serial reproduction of narratives. *Personality and Social Psychology Bulletin*, *26*(5), 594–604.

Kendal, R. L., Boogert, N. J., Rendell, L., Laland, K. N., Webster, M., & Jones, P. L. (2018). Social learning strategies: Bridge-building between fields. *Trends in Cognitive Sciences*, *22*(7), 651–665. https://doi.org/10.1016/j.tics.2018.04.003

Laland, K. N. (2004). Social learning strategies. *Animal Learning & Behavior*, *32*(1), 4–14.

Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition and Emotion*, *14*(4), 473–493. https://doi.org/10.1080/026999300402763

Lewandowsky, S., Cook, J., Fay, N., & Gignac, G. E. (2019). Science by social media: Attitudes towards climate change are mediated by perceived social consensus. *Memory & Cognition*, *47*(8), 1445–1456. https://doi.org/10.3758/s13421-019-00948-y

Marteau, T. M., & Bekker, H. (1992). The development of a six-item short-form of the state scale of the Spielberger State—Trait Anxiety Inventory (STAI). *British Journal of Clinical Psychology*, *31*(3), 301–306.

Mesoudi, A., Whiten, A., & Dunbar, R. (2006). A bias for social information in human cultural transmission. *British Journal of Psychology*, *97*(3), 405–423.

Micklos, A., Walker, B., & Fay, N. (2020). Are people sensitive to problems in communication? *Cognitive Science*, *44*(2), e12816. https://doi.org/10.1111/cogs.12816

Morin, O., & Acerbi, A. (2017). Birth of the cool: A two-centuries decline in emotional expression in Anglophone fiction. *Cognition and Emotion*, *31*(8), 1663–1675. https://doi.org/10.1080/02699931.2016.1260528

Moussaïd, M., Brighton, H., & Gaissmaier, W. (2015). The amplification of risk in experimental diffusion chains. *Proceedings of the National Academy of Sciences*, *112*(18), 5631–5636. https://doi.org/10.1073/pnas.1421883112

Murdock, Jr., B. B. (1962). The serial position effect of free recall. *Journal of Experimental Psychology*, *64*(5), 482–488. https://doi.org/10.1037/h0045106

Nairne, J. S., Pandeirada, J. N. S., & Thompson, S. R. (2008). Adaptive memory: The comparative value of survival processing. *Psychological Science*, *19*(2), 176–180. https://doi.org/10.1111/j.1467-9280.2008.02064.x

Nölle, J., Fusaroli, R., Mills, G. J., & Tylén, K. (2020). Language as shaped by the environment: Linguistic construal in a collaborative spatial task. *Palgrave Communications*, *6*(1), 27. https://doi.org/10.1057/s41599-020-0404-9

Peeters, G., & Czapinski, J. (1990). Positive-negative asymmetry in evaluations: The distinction between affective and informational negativity effects. *European Review of Social Psychology*, *1*(1), 33–60.

Pelletier, P., & Drozda-Senkowska, E. (2020). Towards a socially situated rumouring: Historical and critical perspectives of rumour transmission. *Social and Personality Psychology Compass*, *14*(6), e12532.

R Core Team. (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Available at: http://www.R-project.org/

Rogers, S. L., & Fay, N. (2016). Stick or switch: A selection heuristic predicts when people take the perspective of others or communicate egocentrically. *PLoS One*, *11*(7), e0159570.

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

Schelling, T. C. (1960). *The strategy of conflict*. Cambridge. MA: Harvard University Press.

Schober, M. F. (1993). Spatial perspective-taking in conversation. *Cognition*, *47*(1), 1–24.

Smith, E. R., & Semin, G. R. (2007). Situated social cognition. *Current Directions in Psychological Science*, *16*(3), 132–135.

Sperber, D. (1996). *Explaining culture: A naturalistic approach*. Cambridge, MA: Cambridge University Press.

Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision-making—Biased information sampling during discussion. *Journal of Personality and Social Psychology*, *48*(6), 1467–1478.

Stubbersfield, J. M., Dean, L. G., Sheikh, S., Laland, K. N., & Cross, C. P. (2019). Social transmission favours the ‘morally good’ over the ‘merely arousing.’ *Palgrave Communications*, *5*(1), 70. https://doi.org/10.1057/s41599-019-0269-y

Stubbersfield, J. M., Tehrani, J. J., & Flynn, E. G. (2015). Serial killers, spiders and cybersex: Social and survival information bias in the transmission of urban legends. *British Journal of Psychology*, *106*(2), 288–307.

Tan, R., & Fay, N. (2011). Cultural transmission in the laboratory: Agent interaction improves the intergenerational transfer of information. *Evolution & Human Behavior*, *32*(6), 399–406.

van Leeuwen, F., Parren, N., Miton, H., & Boyer, P. (2018). Individual choose-to-transmit decisions reveal little preference for transmitting negative or high-arousal content. *Journal of Cognition and Culture*, *18*(1–2), 124–153.

Vosoughi, S., Roy, D., & Aral, S. (2018). The spread of true and false news online. *Science*, *359*(6380), 1146–1151. https://doi.org/10.1126/science.aap9559

Walsh, S. P., White, K. M., & Young, R. M. (2010). Needing to connect: The effect of self and others on young people’s involvement with their mobile phones. *Australian Journal of Psychology*, *62*(4), 194–203. https://doi.org/10.1080/00049530903567229

Walter, N., & Tukachinsky, R. (2020). A meta-analytic examination of the continued influence of misinformation in the face of correction: How powerful is it, why does it happen, and how to stop it? *Communication Research*, *47*(2), 155–177. https://doi.org/10.1177/0093650219854600

Wilson, E. J., MacLeod, C., Mathews, A., & Rutherford, E. M. (2006). The causal role of interpretive bias in anxiety reactivity. *Journal of Abnormal Psychology*, *115*(1), 103–111.

Winters, J., Kirby, S., & Smith, K. (2015). Languages adapt to their contextual niche. *Language and Cognition*, *7*(3), 415–449. https://doi.org/10.1017/langcog.2014.35

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