

Pre-registration document: Content biases in large language models using transmission chain experiments.

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Introduction

We used the 9 January 2023 version of OpenAI's GPT-3 language model (publicly available at: <https://chat.openai.com/chat>), to run a series of experiments inspired by psychological literature on transmission chains. Transmission chain experiments are controlled versions of the telephone game, where participants are asked to listen (or read) to a story and repeat it. Transmission chain experiments often highlight the presence of cognitive biases where certain types of information are retained and transmitted more successfully than others (content biases).

We selected five studies (see below) that highlighted in human participants different content biases, and that made use of single stories with different biases (as opposed to experiments that used two stories or more stories with different biases). In one case (study 3), we modified the original material, which consisted in four stories testing four different biases, creating a single story.

We used the same material (stories) of the original experiments (modifications are reported below). The material was presented in chatGPT with the prompt:

*Please summarise this story making sure to make it shorter, if necessary you can omit some information: **story***

For each study, we run five different chains/replications, and each chain/replication consisted of three steps. In each chain, the original story was presented with the prompt above; the output produced by chatGPT was then presented again with the same prompt (step 2), and the process was iterated a last time (step 3). (The setup is slightly different for study 4, see below). The outputs were collected and will be analysed as detailed below. The number of chains/replications and of steps was chosen after pre-tests showing a limited variability of chatGPT's outputs given the same prompt, and that the main modification of the material was happening in the first step of the chain.

The general hypothesis we test is that chatGPT's output will produce the same biases found in human subjects. While the original studies use different statistical analyses, we decided to have the same general analytic strategy for all studies. We will use linear mixed effects models with the *proportion* of content retained as the outcome, the *type*

of content as the predictor, and the steps in the chain and the replication as random effects. Using the R package lme4 (Bates et al., 2015) the general formula can be written as:

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lmer(proportion ~ content + (1|chain_step) + (1|chain_id))
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Detailed hypotheses and implementations are presented below for each study, as well as how the outputs will be coded.

We do not plan to compare results between studies (e.g., whether one bias may be stronger than another). We may compare the results with the results in the original studies with human participants (e.g., effect sizes), but this will depend on the results of the current analysis. If we do, we will consider these as non-pre-registered, exploratory, analyses.

The data have been collected, but not analysed, at the time of this pre-registration.

Study 1. Stereotype consistency

Source: Kashima (2000)

Story:

"Sarah and James live together in a small apartment in Melbourne. James is an up-and-coming executive in a top city firm where Sarah also works as a highly competent personal assistant. This particular Saturday is extremely important because they are entertaining James's employer; James's promotion is at stake and he wishes to make a good impression. James has been awaiting this for a long time, and the possibility of a raise is crucial for their plans to start a family. Sarah has promised to cook a beautiful three-course meal and to make it a successful evening altogether.

They spend the morning shopping at Sarah's favorite, exclusive delicatessens. Sarah even gets her hair done for the occasion while James takes the opportunity to choose the appropriate wine. That morning, James also cleans the house, vacuuming through the entire house and arranging some flowers. Sarah has set up the kitchen and makes some initial preparations for dinner, which she will finish later that afternoon. She then makes lunch and they take a break together.

The phone rings. It's a couple of Sarah's mates from squash; she hangs up and rushes into the bedroom. She yells to James that the girls are down at the Royal and that she's just going to pop down and have a few drinks with them. She gives him a quick peck on the cheek and says she won't be long.

Feeling good about the preparations for that evening, and confident it was going to run smoothly, James settles down for an afternoon of Wide World of Sports. This week they're crossing live to the Brazilian Grand Prix. It was a good afternoon for a bit of TV.

James wakes to the phone ringing and it dawns on him that he's been asleep all afternoon. He crawls off the couch but misses the phone. Wandering into the kitchen, he sees the preparation for dinner; Sarah was not yet home. Could it have been Sarah trying to ring? He tries her mobile but it isn't switched on and James begins to worry. Sarah didn't usually stay at the pub this long, and she had so much to do. He realizes he must do something and opens the cookbook placed on the bench. He isn't exactly sure what Sarah had planned to cook.

It is 6 o'clock and James is whipping the cream for dessert, he hears voices and the door slam shut. Laughing, Sarah runs in and gives James a big hug. James angrily pushes her away, yelling "Where the hell have you been?" Sarah, still laughing, tells

James that she had so much fun drinking with the girls that she invited Brooke and Nat back for the dinner party.

As Sarah and her friends went to freshen up, the doorbell rang. James couldn't believe this was happening."

Coding:

We record the number of propositions that are retained from the original material in successive iterations (based on coding provided in the original paper). Propositions are defined as a predicate plus a series of ordered arguments. As precise wording is unimportant for the propositional representation, propositions do not need to use the exact words, to be considered as retained (see Mesoudi, et al., 2006).

The text used for coding is below. Each proposition is separated by a slash. PMC = plot-relevant male stereotype-consistent; PFC = plot-relevant female stereotype-consistent; PMI = plot-relevant male stereotype-inconsistent; PFI = plot-relevant female stereotype-inconsistent; BMC = background male stereotype-consistent; BFC = background female stereotype-consistent; BMI = background male stereotype-inconsistent; BFI = background female stereotype-inconsistent.

Notice some propositions were not coded with the above classifications as they were classified as 'gender-neutral' by independent judges in the original study .

Text for coding:

Sarah and James live together in a small apartment in Melbourne./ James is an up-and-coming executive in a top city firm (BMC)/ where Sarah also works as a highly competent personal assistant. (BFC)/ This particular Saturday is extremely important because they are entertaining James's employer; (PMC)/ James's promotion is at stake and he wishes to make a good impression. (PMC)/ James has been awaiting this for a long time, (PMC)/ and the possibility of a raise is crucial for their plans to start a family./ Sarah has promised to cook a beautiful three-course meal/ and to make it a successful evening altogether. (PFC)/

They spend the morning shopping/ at Sarah's favorite, exclusive delicatessens. (BFC)/ Sarah even gets her hair done for the occasion (BFC)/ while James takes the opportunity to choose the appropriate wine. (BMC)/ That morning, James also cleans the house, (BMI)/ vacuuming through the entire house (BMI)/ and arranging some flowers. (BMI)/ Sarah has set up the kitchen and makes some initial preparations for dinner, (PFC)/ which she will finish later that afternoon. (PFC)/She then makes lunch (BFC)/ and they take a break together./

The phone rings./ It's a couple of Sarah's mates from squash; (PFI)/ she hangs up and rushes into the bedroom./ She yells to James that the girls are down at the Royal (BFI)/and that she's just going to pop down and have a few drinks with them. (PFI)/ She gives him a quick peck on the cheek (BFC)/ and says she won't be long. (PFI)/

Feeling good about the preparations for that evening,/ and confident it was going to run smoothly, (BMC)/ James settles down for an afternoon of Wide World of Sports. (BMC)/ This week they're crossing live to the Brazilian Grand Prix./ It was a good afternoon for a bit of TV./

James wakes to the phone ringing/ and it dawns on him that he's been asleep all afternoon. (PMC)/ He crawls off the couch/ but misses the phone./ Wandering into the kitchen, he sees the preparation for dinner;/ Sarah was not yet home./Could it have been Sarah trying to ring?/ He tries her mobile but it isn't switched on/ and James begins to worry. (PMI)/Sarah didn't usually stay at the pub this long, (PFI)/ and she had so much to do. (PFC)/ He realizes he must do something (PMI)/ and opens the cookbook placed on the bench. (PMI)/He isn't exactly sure what Sarah had planned to cook./

It is 6 o'clock/ and James is whipping the cream for dessert, (PMI)/ he hears voices and the door slam shut./ Laughing,Sarah runs in/ and gives James a big hug. (BFI)/ James angrily pushes her away, yelling "Where the hell have you been?"(BMC)/ Sarah, still laughing, (BFI)/tells James that she had so much fun drinking with the girls (PFI)/ that she invited Brooke and Nat back for the dinner party. (PFI)/

As Sarah and her friends went to freshen up, (PFC)/ the doorbell rang./ James couldn't believe this was happening.

Analysis

We use:

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lmer(proportion ~ content + (1|chain_step) + (1|chain_id))
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Where "proportion" is the proportion of sentences of each content retained at each step and in each chain, and content can be one of "PMC", "PFC", "PMI", "PFI", "BMC", "BFC", "BMI", "BFI" (see above).

Our hypothesis is that stereotype-consistent content ("PMC", "PFC", "BMC", "BFC") will be a significant predictor of proportion retained.

Study 2: Negativity

Source: Bebbington et al. (2017)

Story:

Sarah is 18 years old. She decided to take some time off before starting university. Her parents were disappointed that Sarah didn't want to start uni right away. Sarah's exam results were due out in a week. She was sure she knew how she had done. Her parents had made her promise to phone with the results. They had always been supportive of her. Sarah had decided to spend some time in the UK. On the day of her trip Sarah arrived at the airport. She was so excited. Sarah boarded the plane and found her seat. As she sat down Sarah found her seatbelt was broken. She called for a flight attendant to ask to be moved to a new seat. The flight attendant told Sarah she would check to see what seats were available. When she returned she told Sarah that she would be moved to business class. Sarah was thrilled. As the plane sped down the runway Sarah noticed how jittery she felt. When the seatbelt light went out Sarah unfastened her seatbelt and pushed her seat back. The seat was so comfortable. There was a young woman sitting in the seat next to Sarah. Sarah decided to start a conversation with her. The woman told her she was travelling for work. As Sarah told her about her travel plans she could tell how interested the woman was in the conversation. An hour into the flight lunch was served. There was a choice between fish and beef. Sarah had once gotten food poisoning from bad fish, so she chose the beef. As Sarah smelled the food she realised she was hungry. Sarah noticed that the meat had an unusual flavour. Sarah had a short stop-over in Dubai. Walking down the concourse, Sarah saw a young man take an old woman's bag. As she walked on further, Sarah saw that one of the stores was having a big sale. She couldn't resist having a quick look. She picked out a top to try on. As she came out of the changerooms, Sarah overheard someone talking about how she looked. As Sarah left the store, she found some money on the ground. As she was putting the note in her pocket, Sarah heard a boarding call for her flight over the PA system. Looking around Sarah realised she had no idea where her gate was. She hurried over to an information desk to ask for directions and she started running toward her gate. She got there just in time! Sarah boarded the plane for the next leg of her trip. The man in the seat next to her seemed to have a nasty cold. Sarah got up from her seat and asked the flight attendant if she could be moved. The flight attendant told her that she would have to stay in her allocated seat. Sarah returned to her seat. She was sure she would catch his cold. During the flight Sarah got up to go to the toilet. There was a long queue. When Sarah reached the front, she was surprised by the condition of the toilet. She moved back to her own seat and reflected on her trip so far. She had been surprised by the quality of the service on the flight.

Coding:

The material from Bebbington and colleagues (2017) was divided into single statements describing an event. We record the number of Negative and Positive event statements that are retained from the original material in successive iterations. As in the original experiment, events are considered to be retained if the 'basic gist' is the same as the original text. In addition, as in the original experiment, we coded whether "ambiguous" sentences were retained as they were or transformed into positive or negative, e.g.: "Walking down the concourse, Sarah saw a young man take an old woman's bag", the man could be helping the old woman (positive) or being a thief stealing her bag (negative).

Text for coding:

Sarah is 18 years old./ She decided to take some time off before starting university./ Her parents were disappointed that Sarah didn't want to start uni right away. (Negative)/ Sarah's exam results were due out in a week./ She was sure she knew how she had done. (Ambiguous)/ Her parents had made her promise to phone with the results./ They had always been supportive of her. (Positive)/ Sarah had decided to spend some time in the UK./ On the day of her trip Sarah arrived at the airport./ She was so excited. (Positive)/ Sarah boarded the plane and found her seat./ As she sat down Sarah found her seatbelt was broken. (Negative)/ She called for a flight attendant to ask to be moved to a new seat. / The flight attendant told Sarah she would check to see what seats were available./ When she returned she told Sarah that she would be moved to business class. (Positive)/ Sarah was thrilled. (Positive)/ As the plane sped down the runway Sarah noticed how jittery she felt. (Ambiguous)/ When the seatbelt light went out Sarah unfastened her seatbelt and pushed her seat back./ The seat was so comfortable. (Positive)/ There was a young woman sitting in the seat next to Sarah./ Sarah decided to start a conversation with her./ The woman told her she was travelling for work./ As Sarah told her about her travel plans/ she could tell how interested the woman was in the conversation. (Ambiguous)/ An hour into the flight lunch was served./ There was a choice between fish and beef. / Sarah had once gotten food poisoning from bad fish, (Negative)/ so she chose the beef./ As Sarah smelled the food she realised she was hungry./ Sarah noticed that the meat had an unusual flavour. (Ambiguous)/ Sarah had a short stop-over in Dubai. / Walking down the concourse, Sarah saw a young man take an old woman's bag. (Ambiguous)/ As she walked on further, Sarah saw that one of the stores was having a big sale. (Positive)/ She couldn't resist having a quick look./ She picked out a top to try on./ As she came out of the changerooms, Sarah overheard someone talking about how she looked. (Ambiguous)/ As Sarah left the store, / she found some money on the ground. (Positive)/ As she was

putting the note in her pocket./ Sarah heard a boarding call for her flight over the PA system./ Looking around Sarah realised she had no idea where her gate was. (Negative)/ She hurried over to an information desk to ask for directions/ and she started running toward her gate./ She got there just in time! (Positive)/ Sarah boarded the plane for the next leg of her trip./ The man in the seat next to her seemed to have a nasty cold. (Negative)/ Sarah got up from her seat/ and asked the flight attendant if she could be moved./ The flight attendant told her that she would have to stay in her allocated seat. (Negative)/ Sarah returned to her seat/ She was sure she would catch his cold. (Negative)/ During the flight Sarah got up to go to the toilet./ There was a long queue. (Negative)/ When Sarah reached the front, she was surprised by the condition of the toilet. (Ambiguous)/ She moved back to her own seat/ and reflected on her trip so far./ She had been surprised by the quality of the service on the flight. (Ambiguous)

Analysis

We use:

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lmer(proportion ~ content + (1|chain_step) + (1|chain_id))
```

Where “proportion” is the proportion of positive and negative sentences retained at each step and in each chain, and content can be one of “positive” or “negative”.

Our hypothesis is that negative content will be a significant predictor of content retained.

For the analysis of ambiguity resolution we use:

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lmer(proportion ~ content + (1|chain_step) + (1|chain_id))
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Where “proportion” is the proportion of ambiguous sentences retained at each step and in each chain (out of the total number of ambiguous sentences), and content can be one of “positive”, “negative,” or “same” (i.e., in case the ambiguous sentence is still ambiguous).

Our hypothesis is that negative content will be a significant predictor of resolutions of ambiguous sentences.

Study 3: Gossip and social information

Source: Mesoudi et al. (2006)

We edited into a single text the four stories of the original experiment.

Story:

Nancy is a college student who lives in Colorado. The weather in Colorado gets hot and dry in the summer. This removes moisture from the soil and dries out the plants that grow there. The dry vegetation catches fire easily, leading to frequent forest fires. These fires release smoke containing carbon monoxide into the atmosphere. This smoke contributes to global warming, increasing temperatures further.

Nancy enjoys swimming. Nancy was going to the swimming pool but got lost, so she asked an old man waiting at a bus stop for directions. The old man could not give her directions. A bus arrived at the bus stop and the old man asked the driver for directions. The driver gave Nancy directions to the swimming pool, so Nancy was able to go swimming.

The next day Nancy's alarm clock broke and she overslept. When she woke up she realised that she was late for an important lecture. She got dressed as quickly as she could, left the house and ran to the lecture theatre. When she got there the lecture theatre was empty. Nancy had missed the lecture.

Nancy is having an affair with her married college professor. Nancy recently became pregnant with the professor's child. The professor promised Nancy that he would leave his wife, but since Nancy told him she was pregnant, the professor refused to see her. So Nancy told the professor's wife about the affair. The professor's wife was so upset that she left the professor.

Coding:

We record the number of propositions that are retained from the original material in successive iterations (based on coding provided in the original paper)

The text used for coding is below. In the original study, the different types of material (social, gossip, individual, physical) were transmitted separately along different chains. Here, we combine the material into a single narrative but retain the different types of material in separate sections. Propositions are illustrated below each section and derived from coding provided by the original authors here:

https://github.com/amesoudi/mesoudi_whiten_dunbar_2006/blob/master/study2_material.pdf

Notice that the first sentence was added to give narrative context but is not included in coding for analysis.

Text for coding

Non-social Physical section:

Nancy is a college student who lives in Colorado [excluded]. The weather in Colorado gets hot and dry in the summer. This removes moisture from the soil and dries out the plants that grow there. The dry vegetation catches fire easily, leading to frequent forest fires. These fires release smoke containing carbon monoxide into the atmosphere. This smoke contributes to global warming, increasing temperatures further.

Propositions:

1. HOT, WEATHER/ 2. DRY, WEATHER/ 3. IN, SUMMER/ 4. REMOVE, MOISTURE, SOIL/ 5. DRY, PLANTS/ 6. CATCH-FIRE, VEGETATION/ 7. EASILY, CATCH-FIRE/ 8. CAUSE, FOREST-FIRES/ 9. FREQUENT, FOREST-FIRES/ 10. RELEASE, SMOKE/ 11. CONTAIN, SMOKE, CARBON-MONOXIDE/ 12. INTO, SMOKE, ATMOSPHERE/ 13. CONTRIBUTE, GLOBAL-WARMING/ 14. INCREASE, TEMPERATURE

Social Non-gossip section:

Nancy enjoys swimming. Nancy was going to the swimming pool but got lost, so she asked an old man waiting at a bus stop for directions. The old man could not give her directions. A bus arrived at the bus stop and the old man asked the driver for directions. The driver gave Nancy directions to the swimming pool, so Nancy was able to go swimming.

Propositions:

1. ENJOY, NANCY, SWIMMING/ 2. GO, NANCY, SWIMMING-POOL/ 3. LOST, NANCY/ 4. ASK, NANCY, MAN/ 5. FOR, DIRECTIONS/ 6. IS, MAN, OLD/ 7. WAIT, MAN, BUS-STOP/ 8. GIVE, MAN, DIRECTIONS, CANNOT/ 9. ARRIVE, BUS, BUS-STOP/ 10. ASK, MAN, DRIVER/ 11. FOR, DIRECTIONS/ 12. GIVE, DRIVER, NANCY, DIRECTIONS/ 13. TO, DIRECTIONS, SWIMMING-POOL/ 14. GO, NANCY, SWIMMING

Non-social Individual section:

The next day Nancy's alarm clock broke and she overslept. When she woke up she realised that she was late for an important lecture. She got dressed as quickly as she could, left the house and ran to the lecture theatre. When she got there the lecture theatre was empty. Nancy had missed the lecture.

Propositions:

1. BROKE, ALARM-CLOCK/ 2. IN, MORNING/ 3. BELONGS-TO, ALARM-CLOCK, NANCY/ 4. OVERSLEEP, NANCY/ 5. WAKE-UP, NANCY/ 6. LATE, NANCY, LECTURE/ 7. IMPORTANT, LECTURE/ 8. DRESS, NANCY/ 9. QUICKLY, DRESS/ 10. LEAVE, NANCY, HOUSE/ 11. RUN, NANCY, LECTURE-THEATRE/ 12. ARRIVE, NANCY, LECTURE-THEATRE/ 13. EMPTY, LECTURE-THEATRE/ 14. MISS, NANCY, LECTURE

Social Gossip section:

Nancy is having an affair with her married college professor. Nancy recently became pregnant with the professor's child. The professor promised Nancy that he would leave his wife, but since Nancy told him she was pregnant, the professor refused to see her. So Nancy told the professor's wife about the affair. The professor's wife was so upset that she left the professor.

Propositions:

1. HAVE, NANCY, AFFAIR/ 2. WITH, AFFAIR, COLLEGE-PROFESSOR/ 3. IS, PROFESSOR, MARRIED/ 4. IS, NANCY, PREGNANT/ 5. PREGNANT-BY, NANCY, PROFESSOR/ 6. PROMISE, PROFESSOR, NANCY, 7/ 7. LEAVE, PROFESSOR, WIFE/ 8. SEE, PROFESSOR, NANCY, REFUSE/ 9. TELL, NANCY, PROFESSOR, 4/ 10. SINCE, 9, 8/ 11. TELL, NANCY, WIFE/ 12. ABOUT, AFFAIR/ 13. UPSET, WIFE/ 14. LEAVE, WIFE, PROFESSOR

Analysis:

We use:

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lmer(proportion ~ content + (1|chain_step) + (1|chain_id))
```

Where "proportion" is the proportion of sentences of each content retained at each step and in each chain, and content can be one of "social-gossip", "social-non-gossip", "non-social-individual", "non-social-physical" (see above).

Our hypothesis is that social information (social and social-gossip) will be a significant predictor of content retained.

Study 4: Threat-related information

Source: Blaine & Boyer, 2018

The original experiment is different from the others, presenting a “consumer report” (see below) followed by 8 statements to help a “friend [that] mentioned that he would like to purchase this product”. In the first iteration, a participant is asked to choose 7 statements, that are then presented to the next participant, that need to choose 6, and 6 on, until three statements remain. The order of the initial 8 statements is randomised.

In this case the prompt was the actual story, without the “*Please summarise this story..., etc.*” as in the other experiment, as the request (“*Please select *n* statements from the following:*”) is part of the script.

As for the previous studies, we run five different chains/replications for each “consumer report.

Stories:

1. *Running Shoes*

Please read the following consumer report about a new running shoe brand called Lancer™.

Lancer™ is a luxury running shoe brand that comes in many shapes and sizes. Recently there has been an up-tick in the market for custom running shoes sold through in person consultation sessions. The company uses a patented customization process to analyze the way a person runs to find where their feet need support. The company then builds a unique shoe tailored to those specifications. With regular use, Lancer™ typically last for up to a year longer than other brands. However, when used for activities other than running, Lancer™’s strap design can cause sprained ankles. Also, Lancer™’s smooth sole can cause runners to slip and fall on certain surfaces. Lancer™’s special fabric may smell if not cleaned properly, and does not come in colors other than white.

Your friend mentioned that he would like to purchase this product. Which items about the product are most important to tell him so that he makes a good decision?

Please select 7 statements from the following:

Lancer™’s strap design can cause sprained ankles when used for activities other than running.

Lancer™’s smooth sole can cause runners to slip and fall on certain surfaces.

Lancer™ special fabric may smell if not cleaned properly.

Lancer™ are only available in white and do not come in other colors.

Lancer™ is a luxury running shoe brand that comes in many shapes and sizes.

Lancer™ customization process analyzes the way you run.

Lancer™ builds a unique shoe tailored especially for you.

Lancer™ shoes last up to a year longer than other brands.

2. One-Step Hair Dye

Please read the following consumer report about a new hair product called Flash Ultra Color™.

Flash Ultra Color™ transforms naturally dark hair into super reflective tones. Using recent advances in hair color technology, Flash Ultra Color™ allows the darkest brunette to achieve bright highlights in one easy step. The product includes premium grapeseed oils in its hair color formula, which is according to the company philosophy: “healthier hair means better color.” Flash Ultra Color™ spreads easily when applied, and has a no-drip guarantee. For customers who currently have color treated hair, there are special considerations. In some instances, hair color may fade in just a few days, and it is important to note that this product cannot be returned after opened. Also, Flash Ultra Color™ can cause severe allergic reactions, and may burn or irritate the scalp if applied to certain skin types. In addition, Flash Ultra Color™ provides an online color selection tool to help you find your preferred shade.

Your friend mentioned that she would like to purchase this product. Which items about the product are most important to tell her so that she makes a good decision?

Please select 7 statements from the following:

Flash Ultra Color™ may burn or irritate the scalp if applied to certain skin types.

Flash Ultra Color™ can cause severe allergic reactions.

Flash Ultra Color™ may fade in just a few days.

Flash Ultra Color™ cannot be returned after being opened.

Flash Ultra Color™ transforms naturally dark hair into super reflective tones.

Flash Ultra Color™ includes premium grapeseed oils in its hair color formula.

Flash Ultra Color™ spreads easily when applied, and has a no-drip guarantee.

Flash Ultra Color™ provides an online color selection tool to find your preferred shade.

3. Topical Acne Medication

Please read the following consumer report about a new acne medication called Nutane™.

Nutane™ is a cream-based acne medication. It is a mixture of exfoliating beads, cooling cream, and antimicrobial solution. Nutane™ is used to treat a variety of acne breakouts over the course of a week. Nutane™ should be applied in a thin layer, and then rinsed with cool water. As part of your skin's natural absorption process, Nutane™ may cause your face to appear slightly greasy for the next few hours, and can smell strong while being applied. Some side effects exist. Nutane™ may burn if applied to certain skin types, and can also cause dizziness if used while dehydrated. Nutane™ is available over-the-counter in all major pharmacies.

Your friend mentioned that he would like to purchase this product. Which items about the product are most important to tell Justin so that he makes a good decision?

Please select 7 statements from the following:

Nutane™ may burn if applied to certain skin types.

Nutane™ can cause dizziness if used while dehydrated.

Nutane™ may cause your face to appear slightly greasy for the next few hours.

Nutane™ may smell strong while being applied.

Nutane™ is a cream-based acne medication.

Nutane™ is a mixture of exfoliating beads, cooling cream, and antimicrobial solution.

Nutane™ should be applied in a thin layer.

Nutane™ is available over-the-counter in all major pharmacies.

Coding

The eight initial statements are coded, in their order, as: threat - threat - negative - negative - neutral - neutral - neutral - neutral. As the text is not reproduced, but we simply asked to select the statement. we just counted the proportion of the statements remaining.

Analysis

We use:

```
lmer(proportion ~ content + (1|chain_step) + (1|chain_id))
```

Where “proportion” is the proportion of statements of each content retained at each step and in each chain, and content can be one of “threat”, “negative”, or “neutral”.

Our hypothesis is that “threat” content will be a significant predictor of content retained relative to both negative and neutral content. In addition, we hypothesise that negative content will be a significant predictor of content retained relative to neutral content. To test this, we use the same model, but without including “threat” as a content.

Study 5: Multiple (social, gossip, survival, positive, negative, moral, counterintuitive)

Source: Berl et al. (2021)

Stories

1. 'Muki'

In the beginning times, Mata and Pata had run away together from the place of their people, far away beyond the realm of the sky, farther away than the stars stretch. The elder ones had not approved of their marriage and so they fled to our world here, which was then only a vast plain. They had with them their Child, Muki, who was the source of their greatest joys.

Here Mata rested with the sleeping Child at her breast, but the rest was short. Their people were hunting them and Muki would slow them when they most needed speed.

Pata took some black clay from his pack. Mata breathed upon the clay and shaped it with her hands, rolling it warm and round. Pata shaped it into a hammock with his hands, weaving its strands together, and hung it on the sky. Mata placed Muki carefully within the hammock, and pressed kisses to the Child's cheek. Then Mata plucked hairs from her own head, and hairs from Pata's chin, and scattered them across the ground. Pata struck his flint, which sent a bright, fiery spark up among the stars. The spark wandered about, bringing warmth and light to the world.

Mata and Pata swore to return one day for Muki. They whispered to her, "Sleep deeply, grow, and be loved."

When Muki woke from dreaming, wanting Mata's breast for her milk and Pata's steady hands for their comfort, they were no longer there. The Child beat her fists upon the earth until it quaked and shuddered. Muki cried and cried, until the spark in the sky darted away, leaving the Child and the world in darkness.

Muki grabbed fists full of clay and scraped out steep valleys in the land. The Child's tantrum churned up the hills as her kicking heels pounded in the earth. Her blood stained the clay, giving life, and she cried huge tears that became the Great River.

From the hairs of Mata's head, a forest of trees grew. The trees grew strong and tall and fruit of many colors sprouted from their branches.

On the shores of the Great River, the hairs of Pata's chin became spiders and crawled up from their bed of clay, moving on eight long, wiry legs. Muki snatched up a spider

and pulled off each of its legs, one by one. The spider, wriggling from the pain, became a snake. Muki then tore the snake in two, dropping half into the water

This half-snake was now the swimming Fish. Muki tried to eat the other half, but Snake bared its fangs full of venom and Muki spat it out with a retch.

When another spider crawled up, this time Muki tore off four of its legs. This spider grew large and became the strong Wolf, which bounded away into the trees.

"Do not go near the Child" called the animals to the next spider who crawled up from the river. But this one was too clever to be caught. Six of its wiry legs twisted around each other to form wings that began to flap. Soaring up above the forest, this spider became the clever Bird.

Then the last Spider summoned together the Snake, the Fish, the Wolf, and the Bird in the forest by the Great River. It was decided that the animals ought to live in different ways. Fish would have the winding river, Wolf would have the shadowed forests, and Snake would have the broad plains. Bird claimed the open skies for itself. "And I will have the hiding places," said Spider.

As they talked, Muki continued to shake the ground. Spider asked, "How will we stop the destruction of our homes?"

Bird said, "I flew high and fast, and I heard shouting voices in the sky. We should give the Child to these other people who search for her."

Snake disagreed, "We should not give the Child to those people, because they are not her people and seek to do her harm."

Wolf said, "Then we must be the Child's people, for it is right to look after children in need."

So Snake, Wolf, and Spider climbed across the Child's belly to tickle her until she laughed. Muki fell back onto the earth, happy and quiet.

Yet the world was still in darkness, as there was no light in the sky. Spider caught sight of the wandering spark in the sky and shouted, "You! You shall be the Sun for our world. When you light the skies and the land Muki will wake, and when you rest and the world darkens, Muki will sleep." The Sun shone proudly, for it is good to have purpose, and it brought the changing of the seasons.

Then out of the clay came our people, those who are our ancestors, because the land around Muki was good and fertile. The Child called Muki became the mountain that

protects our village. We knew then as we do today that the Child must never be alone again, and we wait for Mata and Pata to return for her.

And when our people say today to our children, "Sleep deeply, grow, and be loved," we say it so that Muki hears this too and knows that she is not alone.

2. *'Taka and Toro'*

In the beginning times, Taka and her younger brother Toro were rowing through a storm and crashed upon a rocky island in the sea. Taka stepped ashore and the sharp rocks cut her feet. Everywhere her blood touched, life sprung forth. The grasses and the trees took root and the people, our ancestors, arose from the drops of blood.

Our ancestors learned from Taka and became her friends, and this made Toro feel jealous. She was always too busy playing with them.

"Oh-ho," cackled Puna, the bird in the palm, "Toro, who will you play with now?"

Toro was saddened by Puna's mocking words. He decided to make his own island. "It will be a new and BETTER island," Toro thought with a grin, "so then everyone will want to play with ME!"

Toro climbed up the palm and with his knife cut down the leaves. These he wove together, and bound with rope.

"Oh-ho," cackled Puna, "That is a raft, not an island, and you have not even performed the proper rites!"

But Toro was clever. He said, "If I promise to feed you and your family until your bellies are full, will you help me? If I give something to you, you must return the favor."

"Well," said Puna, "Our bellies are never full. But what is your plan?"

Placing his fingers in his mouth, Toro blew a whistle so piercing that Puna fell from her perch in terror. From out of the jungle came a mass of red ants.

"Why do you call us?" they demanded in their many tiny voices.

"I am building a new island," Toro announced, "And if you help me you can be the first to live there and can take the best homes for yourselves."

The ants agreed, and soon thousands of them came marching out of the jungle, carrying palm leaves on their backs. Toro continued to weave the leaves and the raft grew so large that it was bigger than Taka's island. The ants crawled up onto the raft.

Then, from the sky, dropped Puna and her family. When the birds were satisfied from feasting upon the ants, they grabbed hold of the edges of the new island and lifted it off of Taka's beach and into the sea. They pulled four times under the watch of the moon, and five under the watch of the sun, and they came to a place where the fish were many.

Toro swam down, down, and bound his island to the sea floor so it would not float away. Toro covered the island with soil and built up huge mountains from the land. The sea was pleased with Toro's new island and so sent coconuts to its shores. The coconuts sprouted into thick groves of palms. Toro was very proud. "My island is now the best of them all," he said to himself.

Yet still only Puna came, and that was to see whether there were more of the tasty ants. Toro was disappointed. He reached beneath the waves and found himself a crab. Toro said to the crab, "You must carry news of this island to my sister's people."

The crab, whose name was Kawa, narrowed his beady eyes and spoke, "That is a long way, and I am too lazy to swim that far."

Puna flew down and ate Kawa, because the lazy are always punished for their carelessness. Puna then carried Kawa's shell, filled with Toro's whispers of the island, and dropped it onto Taka's beach. All across Taka's island, the people began to speak of the rumors.

Hoki told his wife Otta, "At the other island, there are so many fish there is no room for them all in the sea. They leap out of the water and into a man's arms like a woman. There are also many palms at the other island, and here there are more neighbours than trees. This is not as it should be."

Over the crashing of the waves, Otta did not hear her husband's words clearly. Otta went and told her sister Kohe, "My husband speaks of other women in his arms! He should not have broken my spirit in this way. If he wishes to go to the new place alone, I will not be sorry."

The people of Taka's island readied their boats together. When these people, our ancestors, came to Toro's island, the island that we call home, they saw that it was all that had been promised.

Taka was not happy that Toro had taken her playmates away. And so she sent the summer storms, making travel dangerous between our two homes. But Taka was an older sister, and like all older sisters, she loved her younger brother in spite of herself. And so she sent the winter trade winds which bring us prosperity and happiness.

We remember this, and today we praise the gods for our good fortune and celebrate.

Coding

Due to the combination of different types of content, coding here is more complex than in the previous studies. To illustrate this, see the first paragraph of 'Muki':

'In the beginning times, Mata and Pata had run away together from the place of their people, far away beyond the realm of the sky, farther away than the stars stretch. The elder ones had not approved of their marriage and so they fled to our world here, which was then only a vast plain. They had with them their Child, Muki, who was the source of their greatest joys.'

This is expressed in the original study in the following 18 propositions:

1. BEGINNING, TIMES/ 2. RUN AWAY FROM, MATA, PATA, PLACE OF PEOPLE/ 3. TOGETHER, MATA, PATA/ 4. FAR AWAY, PLACE OF PEOPLE 5. BEYOND, PLACE OF PEOPLE, REALM OF SKY/ 6. FARTHER AWAY THAN, PLACE OF PEOPLE, STARS STRETCH/ 7. NOT APPROVE OF, ELDER ONES, MARRIAGE/ 8. MARRIAGE, MATA, PATA/ 9. FLEE TO, MATA, PATA, WORLD/ 10. OUR, WORLD/ 11. HERE, WORLD/ 12. SO, 7, 9/ 13. PLAIN, WORLD/ 14. VAST, PLAIN/ 15. WITH, MATA, PATA, MUKI/ 16. CHILD, MUKI, MATA, PATA/ 17. SOURCE OF JOYS, MUKI, MATA, PATA/ 18. GREATEST, JOYS

As in other studies, propositions are coded as containing different types of informational content. Here the content is coded as social-basic, social-gossip, survival, emotional-positive, emotional-negative, moral, rational, and counterintuitive.

Counterintuitive content is coded as mental counterintuitive, physical counterintuitive, and biological counterintuitive. For example the proposition TOGETHER, MATA, PATA is coded as social-basic; the proposition FARTHER AWAY THAN, PLACE OF PEOPLE, STARS STRETCH is coded as physical counterintuitive (a breach of folk physics); and the proposition FLEE TO, MATA, PATA, WORLD is coded as emotional-negative. Some propositions are coded as containing multiple types of information, for example the proposition NOT APPROVE OF, ELDER ONES, MARRIAGE is coded as social-gossip and moral. Please see the coding guide provided by the authors of the original study for full coding details: <https://osf.io/ck64e>

Analysis:

We use:

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lmer(proportion ~ content + (1|chain_step) + (1|chain_id))
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Where “proportion” is the proportion of statements of each content retained at each step and in each chain, and content can be one of social-basic, social-gossip, survival, emotional-positive, emotional-negative, moral, rational, and counterintuitive (physical, mental or biological).

Our hypothesis, consistently with the original paper findings, is that social, negative emotional and counterintuitive (biology) will be significant predictors of proportion retained, while other content will not.

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