Stable Truthiness Effect Across the Lifespan

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Daniel G. Derksen and Megan E. Giroux

Department of Psychology, Simon Fraser University

Eryn J. Newman

Department of Psychology, Australian National University

Daniel M. Bernstein

Department of Psychology, Kwantlen Polytechnic University

Author Note

Daniel G. Derksen (https://orcid.org/0000-0002-1672-3778)

Megan E. Giroux (https://orcid.org/0000-0003-4157-2294)

Eryn J. Newman (https://orcid.org/0000-0001-8663-7173)

Daniel M. Bernstein (https://orcid.org/0000-0003-2716-2344)

Daniel G. Derksen, Department of Psychology, Simon Fraser University; Megan E. Giroux, Department of Psychology, Simon Fraser University; Eryn J. Newman, Department of Psychology, Australian National University; Daniel M. Bernstein, Department of Psychology, Kwantlen Polytechnic University

Though we did not pre-register the combined data analysis, we pre-registered the first of the two individual samples on Open-Science Framework (OSF) prior to data collection (Giroux et al., 2018). All data (Derksen et al., 2018-2020a) and stimuli (Derksen et al., 2018-2020b) are also available on OSF. There are no conflicts of interest to declare. This work was supported by a Doctoral Canadian Graduate Scholarship from the Social Sciences and Humanities Research Council (SSHRC) held by Daniel G. Derksen, a Vanier Canadian Graduate Scholarship from SSHRC held by Megan E. Giroux, and a Canada Research Chairs award [950-228407] held by Daniel M. Bernstein.

Correspondence should be sent to Daniel G. Derksen, Department of Psychology, Simon Fraser University, 8888 University Dr, Burnaby, BC, V5A 1S6. dgderkse@sfu.ca

Abstract

When semantically related-photos appear with true-or-false trivia claims, people more often rate the claims as true compared to when photos are absent—*truthiness.* This occurs even when the photos lack information useful for assessing veracity. We tested whether truthiness changed in magnitude as a function of participants' age in a diverse sample using materials appropriate for all ages. We tested participants (*N* = 414; Age range = 3 – 87 years) in two culturally-diverse environments: a community science center (First language: English (61.4%); Mandarin/Cantonese (11.6%); Spanish (6%), Other (21%); ethnicity: unreported) and a psychology lab (First language: English (64.4%); Punjabi (9.8%); Mandarin/Cantonese (7.4%); other (18.4%); ethnicity: Caucasian (38%); South Asian (30.7%); Asian (22.7%); other/unreported (8.6%). Participants rated trivia claims as true or false. Half the claims appeared with a semantically-related photo, and half appeared without a photo. Results showed that participants of all ages more often rated claims as true when claims appeared with a photo; however, this truthiness effect was stable across the lifespan. If truthiness age differences exist, they are likely negligible in the general population.

Keywords: truthiness, lifespan cognition, childhood, adolescence, adulthood

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"True or false? Hippopotamus milk is bright pink." The truth status of this claim is likely ambiguous for most people who have little information available to determine the correct response. However, a growing literature suggests that if a photo of a hippopotamus appeared with this trivia question, people may be more inclined to think the question was true compared to if it appeared alone (Abed et al., 2017; Fenn et al., 2013; Newman et al., 2012; Newman et al., 2015; Newman et al., 2020). Regardless of whether the claim is true or false, photos can make less-known trivia claims feel more truthful, even if the photo lacks useful information (i.e., the color of the milk). Importantly, the photo must be contextually related to the claim for this effect to occur (see Newman et al., 2015). This bias towards truth in the presence of related, but non-probative (i.e., not indicative of truth) information such as photos has been coined *truthiness.*

Truthiness is not exclusive to trivia claims. Non-probative but related photos also increase perceived credibility of both expert and non-expert witnesses in forensic contexts (Derksen et al., 2020; Sanson et al., 2020), increase the propensity for people to misremember past events (Cardwell et al., 2016; Wade et al., 2002), and increase 'likes' and 'shares' in a social media environment (Fenn et al., 2019). The existing empirical research suggests that truthiness occurs throughout a variety of judgment contexts because non-probative but related photos make claims feel subjectively easier to process (i.e., increase *processing fluency*) compared to when no photo is present (e.g., Jacoby & Dallas, 1981; Whittlesea, 1993). According to fluency-based accounts, a photo may help people picture and process a claim more easily (Cardwell et al., 2017; Schwarz & Newman, 2017). Subsequently, truthiness occurs when people use this fluency as a heuristic (mental shortcut) for truth (see also Tversky & Kahneman, 1973). Specifically, people can mistake the ease with which they process the trivia claim as evidence that the claim is true rather than correctly attributing that ease to the presence of the non-probative but related photograph (Newman et al., 2015; Schwarz & Newman, 2017; see also fluency misattribution, Jacoby & Whitehouse, 1989).

All published work on truthiness to date has been conducted on adults. However, there are at least two reasons to expect age differences in truthiness. The first is that mechanisms that may amplify or reduce truthiness operate differently across development. For example, children may be more likely to rely on a non-probative photo for information if they lack knowledge or experience with the subject matter (see Strough et al., 2011). And via the same mechanism, older adults may be less susceptible to truthiness because they have a larger pool of general intelligence to draw on when assessing the truth status of general knowledge claims, reducing reliance on fluency-based cues to truth (see Brashier et al., 2017). However, we also know that source memory accuracy has been shown to decrease linearly within adulthood (Cansino et al., 2013). This reduced ability to monitor the source of information could increase source misattributions, increasing the extent to which information from the photo affects decision-making. This would subsequently lead to greater truthiness effects for older adults compared to other age groups. The second reason one may observe age differences in truthiness is because of cohort effects. For example, differences in the amount of exposure to technology, advertising, or media across time could change the way that people of different ages process related photos in digital and print media. While research shows that photos tend to capture attention on websites (see Fenn et al., 2019), these cognitive consequences of photos may not hold across cohorts more saturated with fast-paced access to an overwhelming volume of visual material. Thus, there are reasons why one might expect differences in truthiness across age. Further, it is unclear whether potential age differences in truthiness magnitude will be linear or non-linear. Truthiness magnitude could increase or decrease linearly across age. Alternatively, we may observe a U-shaped pattern of truthiness magnitude if the magnitude is similar for young and old age groups but different for those in between. We take the first step toward investigating whether these potential differences in the truthiness effect across age emerge. If we observe differences, more focused research could fruitfully test each potential mechanism in turn.

Understanding truthiness across the lifespan is important in this era of misinformation, disinformation, and fake news. Erroneously judging truth can have widespread consequences for all ages. A child may be biased by photos of toys promising excitement and fun but without showing how the toy actually works. An adolescent may be taken in by a university advertisement containing a non-probative photo of a school. Even worse, an older adult may be influenced by photos related to fraudulent scams that often target this demographic, such as the sale of ineffective medical supplements or reverse mortgages (e.g., with photos of pills/real estate) that could lead to dire consequences for their health or financial well-being. Truthiness studies add to the work on truth assessments by examining the impact of non-probative photos, and more broadly, non-probative conceptual information, on people's impressions of truth. Whether online or in print media, or even in advertising within an app, headlines and claims often appear with non-probative photos which may bias truth judgements (Fenn et al., 2019; Garry et al., 2007; Sacchi et al., 2007).

We developed an "all ages" truthiness paradigm to measure this truth bias across the lifespan, both in the lab and in more naturalistic, ecologically valid settings. Because this was the first all-ages truthiness study, our hypotheses regarding the relationship between truthiness and age were exploratory.

Method

Participants

We pre-registered our science-center sample using Open Science Framework to formally state our experimental design, hypotheses, methods, sample, etc. prior to data collection (see van't Veer & Giner-Sorolla, 2016). After obtaining research ethics approval (Truthiness Across the Lifespan, Kwantlen Polytechnic University, REB# 2018-027), we recruited a total of 449 participants. The initial 280 participants were visitors to a local science center (Science World) in Vancouver, British Columbia, Canada who voluntarily approached a booth to participate in the study. To be eligible, participants had to be at least 3 years old. Of these participants, five withdrew from the study early because they lost interest. Two participants were excluded because they were under 3 years of age. An additional five were excluded because they had 25% or more missing data. A total of 16 participants were excluded for having static responses (either responding "true" to every trivia claim or responding "false" to every trivia claim). One participant was excluded due to having two or more responses missing from a single trial type (e.g., photo-present, true trivia). To ensure English language comprehension did not affect the results, we collected self-reported written and spoken English language fluency. Parents provided this information for themselves (if they participated) and their children. For participants aged 3-5, we showed them the tablets and read the trivia claims to them. For ages 6-9, we asked if they would like to read on their own or have us read to them. As such, participants' verbal comprehension was more essential than written comprehension for completing the task. In the Science Center data, 5 participants reported poor spoken English and 40 participants reported poor written English. In the lab-based data, only 132/163 participants reported fluency information. Of those participants who reported, 0 reported poor spoken English and 13 reported poor written English. Excluding these participants did not change the pattern of results so we retained them for all analyses. The exclusion criteria were pre-registered.

In total, our science-center sample contained 251 participants (125 females; 120 males; 6 unreported; first language: English (61.4%); Mandarin/Cantonese (11.6%); Spanish (6%), other (21%); ethnicity: unreported). Though all participants provided an age range, 235 participants provided their birth date. We used birth dates to calculate exact age. Exact ages (in years) ranged from 3.05-75.68 ($M = 20.13$; $SD = 16.91$). Estimates of the exact ages of the remaining 16 participants were imputed by taking the average age in each age category (3.00-5.99 years; 6.00-9.99 years; 10.00-17.99 years; 18.00 – 64.99 years; 65+). This imputation procedure was not pre-registered.

An additional 169 participants were recruited from a large lab-based longitudinal study that included a variety of social cognition tasks that we do not report here (see Bernstein, 2021). The full lab-based study took 60-90 minutes to complete, with the truthiness task occurring at the end of the testing battery. We added the truthiness task to this larger task battery in November of 2018, but we did not pre-register it. We stopped data collection in early March of 2020 due to COVID-19. Of these 169 participants, four were excluded due to having 25% or more missing data, one participant was excluded due to having two or more responses missing from a single trial type, and one participant was excluded for having static responses. Thus, there were 163 participants in our lab-based sample (104 females; 59 males; Age range = 3.31-86.91; $M_{AGE} = 27.33$; $SD_{AGE} = 22.85$; first language: English (64.4%); Punjabi (9.8%); Mandarin/Cantonese (7.4%); other (18.4%); ethnicity: Caucasian (38%); South Asian (30.7%); Asian (22.7%); other/unreported (8.6%)). All participants in the lab-based sample provided their birthday, thus their exact ages could be calculated. The combined sample contained 414 participants (*M* = 23.12; *SD* = 19.81). The age distribution of the combined sample appears in Figure 1.

We pre-registered all exclusion criteria that we used for the science-center sample (Giroux et al., 2018). We planned to exclude those who failed knowledge-check questions (e.g., “True or false? Babies are smaller than grown-ups.”) and those who self-reported issues with English language fluency. However, we did not measure knowledge-check questions and self-reported fluency in the lab-based sample, and we wished to use uniform exclusion criteria for the combined sample. We also wished to maximize inclusions across both samples. This change to the exclusion criteria did not change the overall data pattern.

Procedure

For participants in the science-center sample, we presented 12 true-or-false claims about plants and animals using a touch-screen tablet to participants of all ages (e.g., see Figure 2). True claims were collected through internet searches for lesser-known facts about plants and animals. False claims were plausible alternatives to the true claims. Photos were simply the subject of the trivia regardless of whether the claim was true or false. For example, the true version of the claim, “Peas are the oldest known vegetable on Earth” appeared alongside a picture of peas whereas the false version, “potatoes are the oldest known vegetable on Earth” appeared with a picture of potatoes. Half the presented claims were true, and half were false. Half the claims appeared with a related, but non-probative photo; half appeared without a photo. Thus, an equal number of each trial type appeared, and each claim had an equal likelihood of appearing with and without a photo. Participants never saw the true and false version of the same claim. The order of presentation was counterbalanced across 4 orders using a partial Latin Square. Participants were instructed to indicate whether each claim was “true” or “false”. They were also informed that the questions were meant to be challenging. We, therefore, encouraged participants to take their best guess if they did not know the answers. For participants ages 3-5, an experimenter read the claim to the participant as they viewed the screen. Participants older than six years completed the task alone if they were comfortable doing so. The study took approximately 5 minutes to complete. The lab-based procedure was nearly identical to the Science Center procedure, except participants completed the task on a computer instead of on a tablet and the study was conducted in a university testing room rather than a public science center. We also added four claims (two true, two false) to the lab-based task. Additionally, for the lab-based sample, instead of using Latin Square counterbalancing, we used a semi-randomized trial order while maintaining an equal proportion of each trial type. All stimuli are on OSF (Derksen et al., 2018-2020b).

Results

We analyzed our data from individual data sets first, and then combined our datasets to maximize power to detect differences in truthiness as a function of age. We used an analysis plan that deviated slightly from what we pre-registered in the science-center sample (Giroux et al., 2018). We pre-registered the categorical analysis but planned to use slightly different age categories than we report here. Originally, we had pre-registered the following age categories in years: 3.00-5.99; 6.00-9.99; 10.00-17.99; 18.00-64.99; 65.00+, however we have subdivided our 10.00-17.99 to 10.00-13.99 and 14.00-17.99 to better capture possible changes in the magnitude of truthiness from middle childhood to adolescence.

Literature on cognitive development in adulthood points to relative stability in early adulthood followed by domain general cognitive decline that continues from around age 30-40 until end of life (Salthouse, 2002; Salthouse & Davis, 2006; Tucker-Drob & Salthouse, 2008).

Therefore, we subdivided our pre-registered 18.00-64.99 age group into 18.00-39.99 and 40.00-64.99 to detect possible differences in truthiness magnitude throughout adulthood. Finally, due to the small number of participants aged 65+ in our sample, we removed this age group from our categorical analysis. Our chosen age categories are consistent with other work involving lifespan cognitive biases and lifespan development (e.g., Bernstein et al., 2011; Salthouse & Davis, 2006).

We also conducted Bayesian analyses to supplement the null-hypothesis significance tests. Conventional null-hypothesis significance tests provide a *p*-value indicating statistical significance, but Bayesian hypothesis tests offer a numerical value called the Bayes Factor (BF). BFs can express evidence in favor of a null hypothesis instead of being inconclusive when $p > .05$. The BF expresses evidence in favor of one model, typically denoted as H1 (evidence for the alternative model) versus H0 (evidence for the null model). A BF of 1 suggests no evidence for either hypothesis; a BF above 1 indicates increasing evidence (> 3 = moderate; > 10 = strong) for H1 over H0; a BF below 1 indicates increasing evidence for H0 over H1 (< 0.33 = moderate; < 0.10 strong; Dienes, 2014; Wagenmakers & Lee, 2014).

We ran Bayesian Repeated Measures ANOVAs and Bayesian bivariate correlations using JASP (JASP Team, 2020). When the results of Bayesian Repeated Measures ANOVAs are reported, model comparisons are typically provided wherein each possible combination of main effects and interactions is compared to both the null model and the best-fitting model. For brevity, when reporting results from the Repeated Measures ANOVAs, we report only the BF_{INCL} across matched models. This compares models that contain the effect of interest to equivalent models that do not (JASP team, 2020). For the bivariate correlations, BF_{10} denotes the evidence for the effect of interest compared to the null model. The data used in all analyses are on OSF. (Derksen et al., 2018-2020a).

Science-Center Sample

To establish that truthiness occurred in the science-center sample, we conducted a 2 (photo: present, absent) x 2 (truth value: true, false) repeated measures ANOVA with the average proportion of claims rated "true" as the dependent variable. There was a main effect of photo, $F(1, 250) = 6.03$; $p = 0.015$; $\eta_p^2 = 0.024$; $BF_{INCL} = 2.172$. Photo-present claims were more often rated "true" compared to photo-absent claims. There was also a main effect of truth value, $F(1, 250) = 16.17$; $p < 0.001$; $\eta_p^2 = 0.061$; $BF_{INCL} = 454.861$. True claims were more often rated true than false claims. The interaction between photo presence and truth value was not significant, $F(1, 250) = 0.49$; $p = 0.484$; $BF_{INCL} = 0.104$. Means and standard deviations are in Table 1.

Next, we investigated whether there were differences in the magnitude of the truthiness effect across our age variable. We calculated a difference score to reflect *truthiness* for each participant by subtracting the proportion of claims rated "true" in photo-present trials from the proportion of claims rated "true" in photo-absent trials. Thus, positive values indicated truthiness. We conducted a bivariate correlation between truthiness and age. The correlation was not significant, $r = -0.059$; $p = 0.353$; $BF_{10} = 0.121$ (see Table 1). We also included age as well as quadratic and cubic transformations of age in a linear regression predicting truthiness. This method can be used to examine whether age has linear and/or nonlinear effects on a predictor variable (i.e., truthiness; see Bernstein, 2021). The pattern of results did not change using the full regression model.

Finally, to test for differences in our categorical age variable in the science-center sample, we conducted a 2 (photo: present, absent) x 2 (truth value: true, false) x 8 (age: 3.00-5.99, 6.00-

9.99, 10.00-13.99, 14.00-17.99, 18.00-39.99, 40.00-64.99) mixed measures ANOVA with the average proportion of claims rated "true" as the dependent variable. There was a main effect of photo, $F(1, 238) = 9.62$; $p = 0.002$; $\eta_p^2 = 0.039$; $BF_{INCL} = 1.858$. Photo-present claims were more often rated "true" compared to photo-absent claims. There was also a main effect of truth value, $F(1, 238) = 16.76$; $p < 0.001$; $\eta_p^2 = 0.066$; $BF_{INCL} = 431.345$. True claims were more often rated true than false claims. The interaction between photo and age category was not significant, $F(5, 238) = 1.69$; $p = 0.137$; $BF_{INCL} = 0.066$. The interaction between truth value and age category was not significant, $F(5, 238) = 1.93$; $p = 0.091$; $BF_{INCL} = 0.175$, nor was the interaction among photo, truth value, and age category, $F(1, 5, 238) = 0.63$; $p = 0.677$; $BF_{INCL} = 0.024$. Means and standard deviations are in Table 2.

Lab-Based Sample

To establish that truthiness was present in the lab-based sample, we again conducted a 2 (photo: present, absent) x 2 (truth value: true, false) repeated measures ANOVA with the average proportion of claims rated "true" as the dependent variable. There was a main effect of photo presence, $F(1, 162) = 13.73$; $p < 0.001$; $\eta_p^2 = 0.078$; $BF_{INCL} = 126.207$. Photo-present claims were more often rated "true" compared to photo-absent claims. There was also a main effect of truth value, $F(1, 162) = 27.11$; $p < 0.001$; $\eta_p^2 = 0.143$; $BF_{INCL} = 3.562 \times 10^4$. True claims were more often rated true than false claims. The interaction between photo and truth value was not significant, $F(1, 162) = 0.01$; $p = 0.93$; $BF_{INCL} = 0.122$. Means and standard deviations are in Table 1.

To investigate whether there were differences in the magnitude of the truthiness effect across our age variable, we conducted a bivariate correlation between truthiness and age. The correlation was not significant, $r = -0.121$; $p = 0.125$; $BF_{10} = 0.314$ (see Table 1). The pattern of results did not change in a regression model with age, age^2 and age^3 predicting truthiness.

Finally, to test for differences in our categorical age variable in the lab-based sample, we conducted a 2 (photo: present, absent) x 2 (truth value: true, false) x 8 (age: 3.00-5.99, 6.00-9.99, 10.00-13.99, 14.00-17.99, 18.00-39.99, 40.00-64.99) mixed measures ANOVA with the average proportion of claims rated "true" as the dependent variable. There was a main effect of photo, $F(1, 140) = 14.52$; $p < 0.001$; $\eta_p^2 = 0.093$; $BF_{INCL} = 127.009$. Photo-present claims were more often rated "true" compared to photo-absent claims. There was also a main effect of truth value, $F(1, 140) = 15.47$; $p < 0.001$; $\eta_p^2 = 0.10$; $BF_{INCL} = 1.493 \times 10^4$. True claims were more often rated true than false claims. The interaction between photo and age category was not significant, $F(5, 140) = 0.49$; $p = 0.781$; $BF_{INCL} = 0.016$. The interaction between truth value and age category was not significant, $F(5, 140) = 1.67$; $p = 0.145$; $BF_{INCL} = 0.126$, nor was the interaction among photo, truth value, and age category, $F(1, 5, 140) = 1.72$; $p = 0.134$; $BF_{INCL} = 0.330$. Means and standard deviations are in Table 2.

Combined Sample

To increase our power to detect differences in truthiness effects across our age variable, we combined the datasets. Note that the two samples yielded similar results (see Table 1). We did not pre-register this combined analysis. When sample (science-center, lab-based) was included in a mixed measures ANOVA (2 (photo: present, absent) x 2 (sample: science-center, lab-based)) with proportion rated true as the dependent variable, the interaction was not significant ($p = 0.30$). Thus, sample did not interact with truthiness.

To establish that truthiness was present in the combined sample, we conducted a 2 (photo: present, absent) x 2 (truth value: true, false) repeated measures ANOVA with the average proportion of claims rated “true” as the dependent variable. There was a main effect of photo, $F(1, 413) = 17.18$; $p < 0.001$; $\eta_p^2 = 0.040$; $BF_{INCL} = 412.57$ Photo-present claims were more often rated “true” compared to photo-absent claims. There was also a main effect of truth value, $F(1, 413) = 38.75$; $p < 0.001$; $\eta_p^2 = 0.086$; $BF_{INCL} = 2.520 \times 10^7$. True claims were more often rated true than false claims. The interaction between photo presence and truth value was not significant, $F(1, 413) = 0.27$; $p = 0.606$; $BF_{INCL} = 0.089$. Means and standard deviations are in Table 1.

To investigate whether truthiness changed in magnitude across our age variable, we conducted a bivariate correlation between truthiness and age. The correlation was not significant, $r = -0.074$; $p = 0.134$; $BF_{10} = 0.188$ (see Table 1). The pattern of results did not change in a regression model with age, age^2 and age^3 predicting truthiness. A scatterplot of truthiness and age appears in Figure 3.

Finally, to test for differences in our categorical age variable in the combined sample, we conducted a 2 (photo: present, absent) x 2 (truth value: true, false) x 8 (age: 3.00-5.99, 6.00-9.99, 10.00-13.99, 14.00-17.99, 18.00-39.99, 40.00-64.99) mixed measures ANOVA with the average proportion of claims rated “true” as the dependent variable. There was a main effect of photo, $F(1, 384) = 25.77$; $p < 0.001$; $\eta_p^2 = 0.063$; $BF_{INCL} = 461.95$. Photo-present claims were more often rated “true” compared to photo-absent claims. There was also a main effect of truth value, $F(1, 384) = 32.50$; $p < 0.001$; $\eta_p^2 = 0.078$; $BF_{INCL} = 2.864 \times 10^6$. True claims were more often rated true than false claims. The interaction between photo and age category was not significant, $F(5, 384) = 1.49$; $p = 0.191$; $BF_{INCL} = 0.022$. The interaction between truth value and age category was significant. $F(5, 384) = 2.33$; $p = 0.042$; $\eta_p^2 = 0.029$; $BF_{INCL} = 0.150$. Pairwise comparisons revealed that true statements were more often rated true than false statements for ages 10.00-13.99 ($p = 0.021$; $dz = 0.09$), 14.00-17.99 ($p = 0.005$; $dz = 0.12$), 18.00-39.99 ($p = 0.007$; $dz = 0.14$), and 40.00-64.00 ($p < 0.001$; $dz = 0.23$) but not for ages 3.00-5.99 ($p = 0.899$), or 6.00-9.99 ($p = 0.103$). The interaction between photo, truth value, and age category was not significant, $F(1, 5, 384) = 0.79$; $p = 0.555$; $BF_{INCL} = 4.958 \times 10^{-7}$. Means and standard deviations are in Table 2.

Discussion

When judging whether a claim is true or false, people may rely on their subjective internal states to determine how true the claim feels (Fenn et al., 2013; Newman et al., 2012; Newman et al., 2015). Non-probative but related photographs can produce such a feeling of truth. We observed this photo bias to respond true in a large sample of participants across the lifespan. We also found a truthiness effect in a naturalistic setting—this is the first experiment to capture truthiness outside of highly controlled lab conditions. When investigating the relation between truthiness and age, we observed a stable non-significant correlation in our individual and combined sample. Further, in our categorical analyses, we did not observe significant interactions between our photo factor and age category factor. Together, these results suggest that truthiness influences judgements similarly across the child-to-adult age range. Because we collected a convenience sample, we did not have enough participants across the adult age range to provide a fine-grained categorical age analysis in adulthood (e.g., using 10-year age groups across adulthood). Instead, we used wider age categories, 18.00-39.99 and 40.00-64.99. Though these wider age categories were still informed by the literature on adult cognitive development that shows continued cognitive change in mid to late life, finer age categories may show more nuanced changes throughout adulthood (Salthouse, 2002; Salthouse & Davis, 2006; Tucker-Drob

& Salthouse, 2008). We also had relatively few older adults in our sample and excluded them from our categorical age analysis. More research is especially needed to investigate truthiness effects in older adults over the age of 65.

There is empirical support that processing fluency, or the subjective experience of how easy it is to process information, is the key mechanism underlying truthiness effects (see Newman et al., 2015; Wilson & Westerman, 2018; Zhang et al., 2021). For example, a picture of a cheetah may help us visualize a cheetah running quickly, which makes the claim easier to imagine and process. This can produce a feeling of ease while processing the question or claim that is often associated with truth (Cardwell et al., 2017; Schwarz & Newman, 2017). An increasing body of research shows that easy processing is often interpreted as a cue to truth but is more generally taken as a cue to criteria that are related to truth such as social consensus, coherence, credibility and compatibility (Schwarz et al., 2016).

The stability of the truthiness effect across age speaks to the very early use of truth cues, such as photos. At the outset we expected that differences might emerge due to differences in the use of truth cues that rely on age and associated changes in knowledge or source tracking. We also considered that differences might arise due to cohort effects such as differences in the use of and exposure to technology and digital media. However, we did not find differences in truthiness across our age variables. Despite likely differences in general knowledge and exposure to technology across our sample, the truthiness effect remained stable. This fits with an emerging body of research on experiential cues in truth judgements showing that these cues to truth are learned early and used by both children and adults in decision making (Fazio & Sherry, 2020; Geurten et al., 2015; 2017; 2020; Guttentag & Dunn, 2003; Jacobs & Klaczynski, 2002). The overlap in the current findings and research on other kinds of truth cues (such as repetitioninduced illusory truth) presents exciting avenues for future research. Specifically, trivia used in truthiness experiments is intentionally obscure and ambiguous. Future developmental research might experimentally manipulate general knowledge or ability to engage in an effortful search through existing knowledge (Fazio & Sherry, 2020). Such an approach could produce developmental differences in truthiness due to differences in the availability of general knowledge, a more declarative input in assessments of truth.

If developmental differences depend on the availability of relevant knowledge, rather than shifts in tracking source or cohort effects, it shouldn't be surprising that we observed a relatively stable truthiness effect across age with our more ambiguous claims. Another possibility is that non-probative but related photos are sometimes used incorrectly as cues for truth due to pedagogical reasons. Participants may be used to learning from photos such as when a teacher uses a visual aid as an example to teach something akin to the very trivia claim that the participant is assessing (see Shafto et al., 2014). Finally, a photo may simply signal thought, care, or expertise, increasing the credibility of the claim (see Weisberg, 2008). Thus, the photo, though non-probative, may be interpreted as evidentiary. Work in adult samples has examined the notion that photos produce an illusion of evidence but found that this cannot explain the truthiness effect (see Zhang et al., 2021). However, this is an interesting avenue to consider in child samples. Indeed, non-probative photos may elicit truthiness for different reasons in different ages.

The consistency of truthiness in our diverse lifespan sample shows that people can be nudged towards believing information with the presence of related photos, potentially leading them astray in assessments of truth (see Thaler & Sunstein, 2009). Belief in false information continues to be a troubling reality in society. Research on belief in false information has focused primarily on individual differences concerning susceptibility to believing false information (e.g., some show differences based on analytical thinking, e.g., Bronstein et al., 2019; other research shows less variance for individual differences in cognitive biases in truth assessment e.g., De Keersmaecker et al., 2020; Newman, et al., 2020). We observed a non-significant interaction between photo presence and truth value. Thus, both factually true and factually false information was more likely to be rated true when non-probative photos were present (compared to when they were absent; see also signal detection analysis in Supplemental Materials). Thus, the effect of truthiness on accuracy is a double-edged sword— non-probative photos can facilitate belief in both false and true information. Further, we acknowledge that there may be individual differences in people's susceptibility to truthiness. The current work showed that truthiness can bias judgements both in a quiet lab setting and a noisy science center. Observing truthiness across testing environments and age suggests that the effect is robust. The relative stability of this bias across age groups is unsettling because it may affect both children and adults alike. Future work should investigate judgement contexts where truthiness may operate for our most vulnerable age groups. It's not all bad though: truthiness can also be used for good by increasing belief in true information when photos appear alongside the facts.

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Table 1

Means, Standard Deviations and Correlations for Individual and Combined Samples (Continuous Analysis)

	Photo Presence	Truth Value	*M*	*SD*	*r*(truthiness, age)
Science Center (*n* = 251)	**Present**	**True**	0.60	0.29	-0.059
		False	0.52	0.33	
		Total	0.56	0.24	
	Absent	**True**	0.55	0.29	
		False	0.49	0.32	
		Total	0.52	0.22	
Lab Based (*n* = 163)	**Present**	**True**	0.64	0.24	-0.121
		False	0.55	0.28	
		Total	0.59	0.22	
	Absent	**True**	0.57	0.24	
		False	0.47	0.24	
		Total	0.52	0.18	
Combined (*N* = 414)	**Present**	**True**	0.62	0.26	-0.074
		False	0.53	0.31	
		Total	0.57	0.23	
	Absent	**True**	0.56	0.26	
		False	0.48	0.28	
		Total	0.52	0.20	

Note. For continuous analyses (i.e., correlation) truthiness was calculated as the difference score between average proportion of trivia rated true in photo-present trials and average proportion rated true in photo-absent trials. Correlations between truthiness and age were not significant (all $ps > 0.05$).

Table 2

Means, Standard Deviations for Individual and Combined Samples (Categorical Analysis)

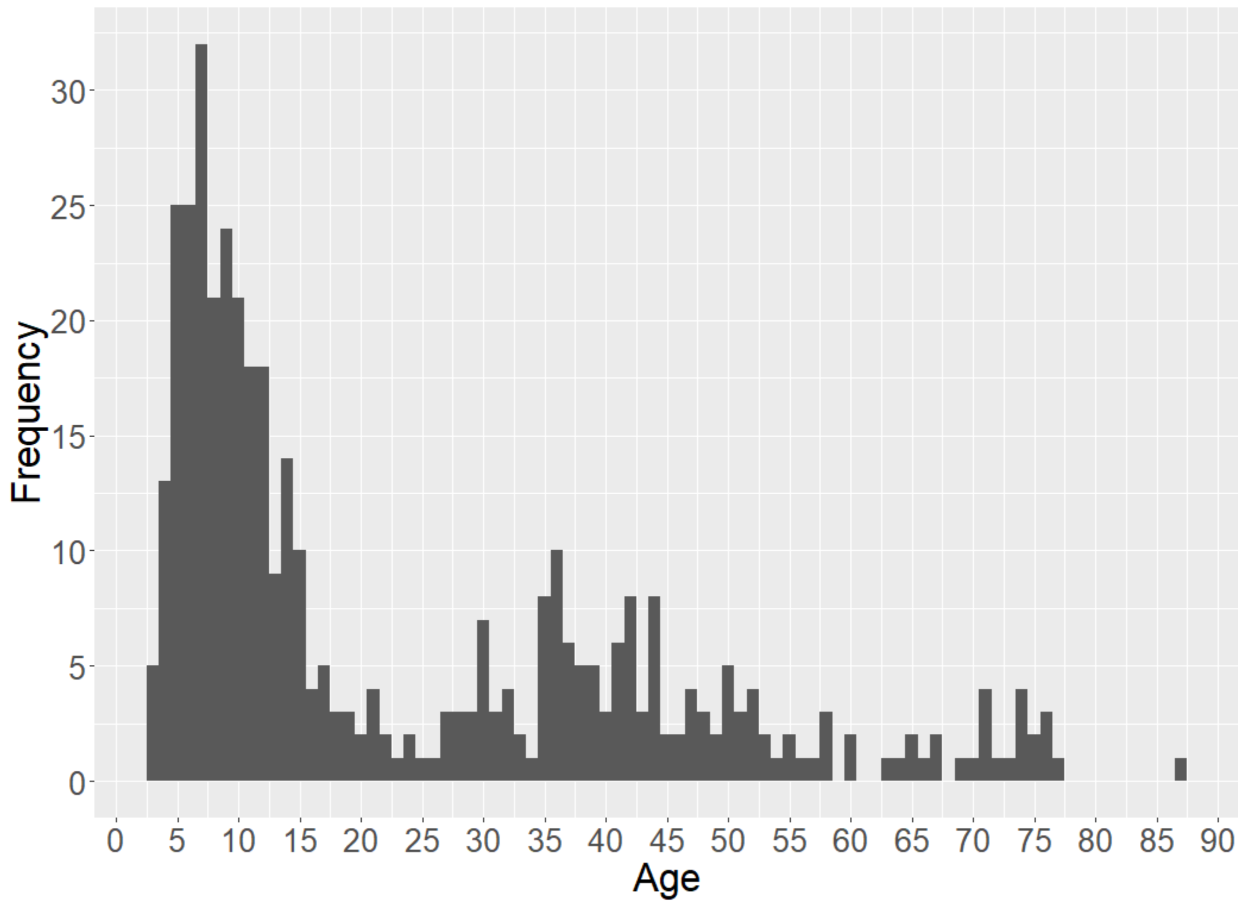
Sample	Age	Photo	Truth	*M*	*SD*
Science Center Sample (N = 244)	3.00 - 5.99 (*n* = 43)	Present	True	0.69	0.67
			False	0.69	0.76
			Total	0.69	0.56
		Absent	True	0.57	0.69
			False	0.62	0.72
			Total	0.59	0.53
	6.00 - 9.99 (*n* = 63)	Present	True	0.58	0.56
			False	0.54	0.63
			Total	0.56	0.46
		Absent	True	0.59	0.57
			False	0.53	0.59
			Total	0.56	0.44
	10.00 - 13.99 (*n* = 33)	Present	True	0.64	0.77
			False	0.52	0.87
			Total	0.58	0.64
		Absent	True	0.57	0.79
			False	0.46	0.82
			Total	0.52	0.60
	14.00 - 17.99 (*n* = 14)	Present	True	0.64	1.18
			False	0.57	1.33
			Total	0.61	0.99
		Absent	True	0.50	1.21
			False	0.33	1.26
			Total	0.42	0.93
	18.00 - 39.99 (*n* = 61)	Present	True	0.55	0.57
			False	0.44	0.64
			Total	0.49	0.47
		Absent	True	0.50	0.58
			False	0.40	0.60
			Total	0.45	0.44
	40.00 - 64.99 (n = 30)	Present	True	0.60	0.81
			False	0.38	0.91
			Total	0.49	0.67

		Absent	True	0.54	0.82
			False	0.47	0.86
			Total	0.51	0.63
Lab-Based Sample (n = 146)	3.00 - 5.99 (*n* = 13)	Present	True	0.65	0.85
			False	0.56	0.92
			Total	0.60	0.69
		Absent	True	0.61	0.81
			False	0.48	0.82
			Total	0.54	0.62
	6.00 - 9.99 (*n* = 37)	Present	True	0.62	0.50
			False	0.63	0.54
			Total	0.62	0.41
		Absent	True	0.55	0.48
			False	0.48	0.48
			Total	0.52	0.37
	10.00 - 13.99 (*n* = 26)	Present	True	0.58	0.59
			False	0.61	0.65
			Total	0.60	0.49
		Absent	True	0.57	0.58
			False	0.46	0.58
			Total	0.51	0.44
	14.00 - 17.99 (*n* = 17)	Present	True	0.71	0.74
			False	0.49	0.81
			Total	0.60	0.60
		Absent	True	0.49	0.71
			False	0.41	0.71
			Total	0.45	0.54
	18.00 - 39.99 (*n* = 18)	Present	True	0.68	0.71
			False	0.57	0.79
			Total	0.63	0.58
		Absent	True	0.55	0.69
			False	0.64	0.70
			Total	0.59	0.53
	40.00 - 64.99 (n = 35)	Present	True	0.64	0.52
			False	0.50	0.57
			Total	0.57	0.42
		Absent	True	0.56	0.50
			False	0.42	0.50

			Total	0.49	0.38
Combined Sample (N = 390)	3.00 - 5.99 (*n* = 56)	Present	True	0.68	0.71
			False	0.66	0.81
			Total	0.67	0.60
		Absent	True	0.58	0.71
			False	0.59	0.75
			Total	0.58	0.55
	6.00 - 9.99 (*n* = 100)	Present	True	0.59	0.53
			False	0.58	0.61
			Total	0.59	0.45
		Absent	True	0.58	0.53
			False	0.51	0.57
			Total	0.54	0.41
	10.00 - 13.99 (*n* = 59)	Present	True	0.61	0.69
			False	0.56	0.79
			Total	0.59	0.58
		Absent	True	0.57	0.69
			False	0.46	0.73
			Total	0.51	0.54
	14.00 - 17.99 (*n* = 31)	Present	True	0.68	0.97
			False	0.52	1.09
			Total	0.60	0.80
		Absent	True	0.49	0.97
			False	0.38	1.01
			Total	0.43	0.74
	18.00 - 39.99 (*n* = 79)	Present	True	0.58	0.61
			False	0.47	0.67
			Total	0.52	0.50
		Absent	True	0.51	0.59
			False	0.46	0.63
			Total	0.48	0.47
	40.00 - 64.99 (n = 65)	Present	True	0.62	0.67
			False	0.44	0.75
			Total	0.53	0.55
		Absent	True	0.55	0.67
			False	0.44	0.69
			Total	0.50	0.51

Figure 1

Age Distribution of Combined Sample



Note. There was an effort to include as many different ages as possible across the lifespan, but the sample was disproportionately represented by children. Exact ages (in years) ranged from 3.05-86.91 (N = 414; M = 23.12; SD = 19.81).

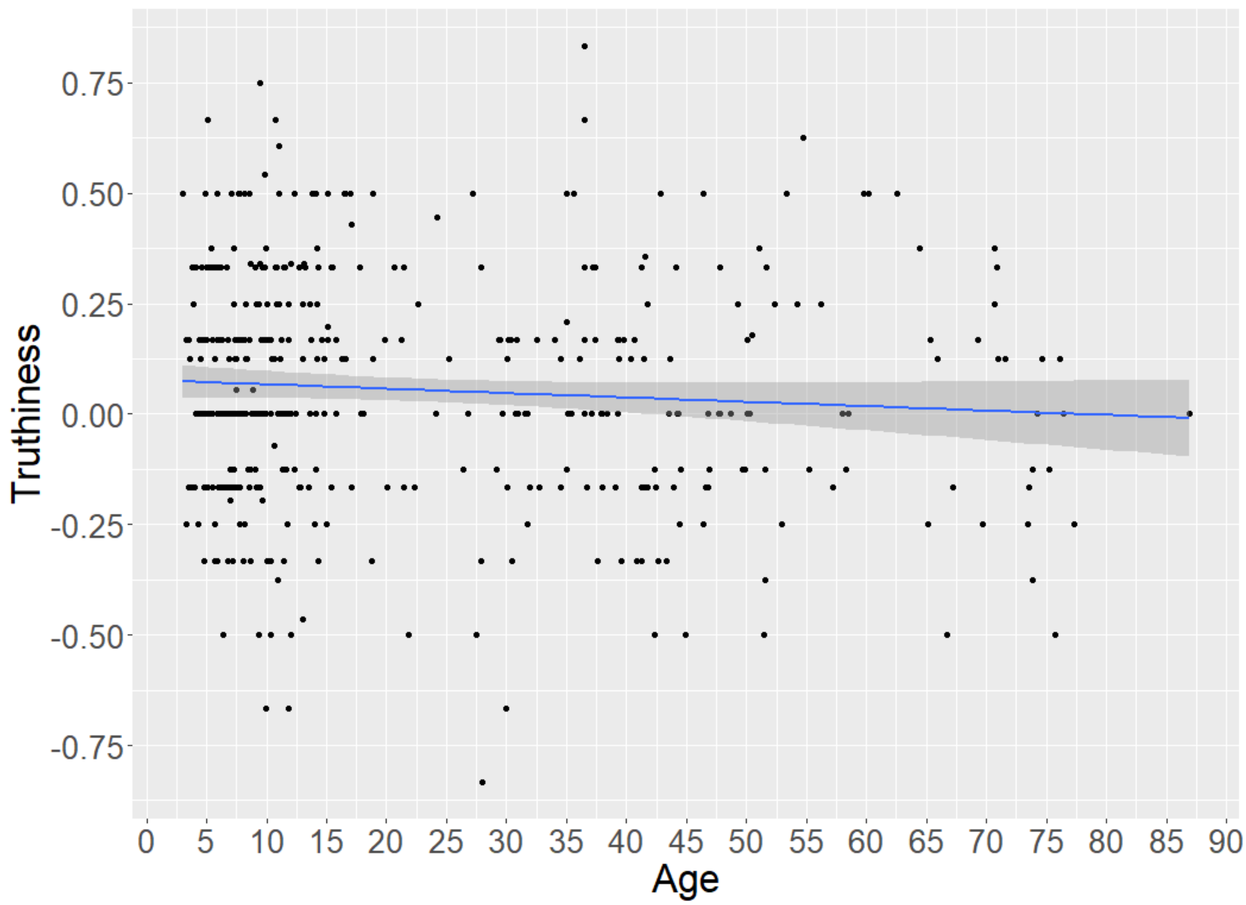
Figure 2

Example of Stimuli Used in Both the Science-Center Study and the Lab-Based Study.

Note. Image source: Tambako the Jaguar (2014) *Baby pigmy hippo walking at the water* [Photograph licensed under CC BY-ND 2.0]. Flickr. https://www.flickr.com/photos/8070463@N03/15140951551. True and false versions of the same trivia were never presented to a participant. Image varies slightly from what was used in the experiment. A full list of stimuli is available on OSF (Derksen et al., 2018-2020b).

Figure 3

Scatteplot of Truthiness and Age in the Combined Sample with Best-Fit Line Showing a Non-Significant Negative Correlation



Note. Truthiness was measured as the difference in the proportion of photo-present claims rated true and the proportion of photo absent claims rated true (N = 414; r = -0.074; p = 0.134).