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# Did Teddy Bears Culturally Evolve to Be Cuter? A Preregistered Replication

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## Abstract

This pre-registered replication study explores the impact of perceived cuteness on the evolution of cultural artifacts, testing whether neotenic traits – eye size, forehead height, and head roundness – have increased in teddy bears over time. In previous research, Hinde & Barden (1980) found an increase in teddy bear neoteny while Gould (1985) found that Mickey Mouse's features became more neotenic with time. However, both studies lacked statistical power (15 teddy bears and 3 Mickey Mouse drawings). We collected data from eight major teddy bear manufacturers over nine decades (N = 250; 1900–1980). We found that the forehead height of teddy bears significantly increased over time. Conversely, our prediction that heads became rounder and eyes became bigger were not supported. We outline four key methodological limitations that future research should address to deepen our understanding of the cultural evolution of cuteness and of cultural artifacts more broadly – i.e., sampling bias, metadata inaccuracy, categorization ambiguity, and function ambiguity.

## Keywords

## 1      Introduction[1]

Lorenz (1950) first mentioned the existence of a set of "innate releasing mechanisms with which we respond to small children". He went on: "A relatively large head, predominance of the brain capsule, large and low-lying eyes, bulging cheek region, short and thick extremities, a springy elastic consistency, and clumsy movements represent the major characters following the law of summation and combining to give a child (or a dummy such as a doll or an animal) a loveable or 'cuddly' appearance." Since then, in both ethology and cognitive science, a literature has emerged on such neotenic features that elicit a perception of *cuteness*.

A range of studies, always involving exposure to faces with variable neotenic features (both within and between participants), have brought standardized measures to bear in determining the characteristics that increase cuteness perception and caretaking behaviors: large head in proportion to the body, protruding forehead, large in proportion to the rest of the face, large eyes below the midline of the total head, and round protruding cheeks (Brooks & Hochberg, 1960; Gardner & Wallach, 1960; Fullard & Reiling, 1976; Sternglanz et al., 1977; Hildebrandt & Fitzgerald, 1978; Little, 2012; Glocker et al., 2009a; Glocker et al., 2009b).

Two studies in cultural evolutionary research claimed that, as time went by, both the Mickey Mouse character and teddy bear toys became cuter, being progressively designed with larger fronts, bigger eyes, and rounder faces (Hinde & Barden, 1985; Gould, 1980; see also Tribot et al., 2023). Such results in our view support an important insight from recent cultural evolutionary research, that culture is highly constrained by human psychology (Sperber & Hirschfeld, 2004). Here, the pleasure humans get from observing cute faces would orient the evolution of the faces of animated characters (independent of their age in the story) in a *non-random direction*.

Think of Disney movies (e.g., *Frozen*, *Nemo*) and Japanese manga (e.g., *One Piece*, *Spy Family*): These cultural productions all seem to enhance some parts of their characters' bodies and faces in directions that fit the cuteness detector mechanism (see Fig. 1). To make this 'non-arbitrariness' more apparent, one can think of counterfactuals. Characters' forms, at least in some traditions, could have changed in other directions: fronts could have gotten smaller, eyes

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FIGURE 1    **A.** Examples of faces exhibiting neotenic features (© DisneyEnterprises, © SpyXFamily, © JumpComics, under fair use). **B.** Anecdotal evidence that, as Hinde and Barden put it, "the artifacts' creators are cognizant of the selective forces"

could have shrinked, faces could have converged toward square-like shapes; and, instead of eyes and fronts, it could have been noses or ears that would have been enlarged.

However, these two studies suffer from important limitations. First, they were based on very limited data. Gould's study was based on only 3 different drawings of Mickey (1930, 1947, 1980) while Hinde and Barden's study was based on only 15 teddy bears (1903–1985). Second, the collected data were not necessarily representative of a larger population: Mickey Mouse is obviously not a randomly chosen character among the Disney family and the selected teddy bears were part of a UK exhibition, increasing the risk of a sampling bias. Finally, the two papers did not use the same measures of cuteness, arguably because research on the input conditions of the associated psychological mechanism had not yet reached a consensus. Gould computed three measurements on Mickey Mouse characters (i.e., eye size relative to the head, head size relative to the body, and cranial vault size) and Hinde and Barden computed two ratios (i.e., forehead size and snout size).

This study is designed as a conceptual replication of Hinde and Barden's study: We (a different team of researchers) test the same hypothesis as the original study, on different data. This is not a direct or close replication as we have decided not to use the original data nor the original measurements exactly.

Because we measured features of teddy bears in digital images, we couldn't measure features that require a profile view (e.g., snout size and cranial vault size). And because such images sometimes display only the head of the teddy bears, we couldn't measure features that required a whole view (i.e., head size relative to the body).

We selected 3 measures of neoteny that have been shown to be correlated with cuteness judgment or caretaking behavior: Eye Size (i.e., a replication of Gould's study), Forehead Height (i.e., a replication of Hinde and Barden's study), and Head Roundness (see Sternglanz et al., 1977; Little, 2012; Glocker et al., 2009).

The hypothesis that teddy bears become cuter with time thus leads to 3 predictions: (1) Eye Size increases with time; (2) Forehead Height increases with time; (3) Head Roundness increases with time (see 2.2. for operationalization). These predictions, the subsequent data collection and annotation methods as well as the planned statistical analysis were all pre-registered (https://osf.io/dbg2x/).

## 2      Method

### 2.1     *Data Collection*
To minimize sampling bias, we decided to target eight different teddy bear manufacturers (i.e., specific makers or brands of teddy bears) that have been in operation for the most extended periods, and look for five teddy bears per manufacturer per decade on the internet, for as many decades as possible, from the 1900s to the 1980s (included; i.e. 9 decades). We selected: Steiff (Germany), Hermann (Germany), Deans (United Kingdom), Merrythought (United Kingdom), Fadap (France), Pintel (France), Ideal (United States) and Gund (United States).

The first step was to collect digitized images of teddy bears. We decided to streamline the process. First, we looked for teddy bears in books that compile images of teddy bears (i.e., *The Teddy Bear Encyclopedia*, Cockrill et al., 1993; *Teddy bears: a guide to their history, collecting, and care*, Hockenberry, 1999; *The ultimate teddy bear book*, Cockrill, 1991). When insufficient to reach the threshold of 5 teddy bears per manufacturer per decade, we looked for more teddy bears in online catalogs from museums or auction houses. When still insufficient, we looked at teddy bears on the Internet (e.g., eBay, Etsy, Pinterest). When we found more than 5 teddy bears for a given manufacturer in a given decade, we randomly picked 5 to minimize selection bias.

Overall, we found 250 teddy bears (33 for Deans, 21 for Fadap, 31 for Gund, 40 for Hermann, 34 for Ideal, 28 for Merrythought, 18 for Pintel, and 45 for Steiff). Note that each teddy bear has been assigned an ID: the first letter of the manufacturer (S for Steiff, H for Hermann, etc.), the decade (00 for 1900s, 10 for 1910s, etc.), an underscore, and a number between 1 and 5. For instance, for the fourth teddy bear of Fadap from the 1930s, the ID is F30_4.

### 2.2    *Measurement*

Our three measures of neoteny were operationalized as follows:

*Eye Size = Ratio of* [*vertical eye length*] *to* [*vertical head length*]

*Forehead Height = Ratio of* [*distance from the midpoint between eyes to the crown*] *to* [*distance from the midpoint between eyes and the base of the head*]

*Head Roundness = Ratio of* [*horizontal head width*] *and* [*vertical head length*]

We determined the distance for each measurement as follows: Vertical eye length was measured from the top to the bottom of the eye, including pupil, iris, sclera, and any defining outlines. Vertical head length goes from the base
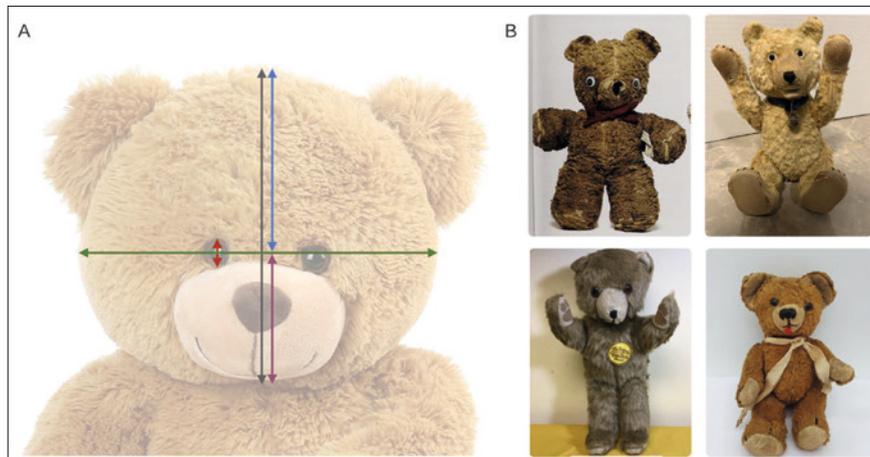


FIGURE 2    **A.** Measures of a teddy bear (in red [vertical eye length], in gray [vertical head length], in blue [distance between the center of the eyes and the crown], in purple [distance between the center of the eyes and the base of the head], in green [horizontal head width]). **B.** Examples of teddy bears in our dataset (here, from left to right and top to bottom, G40_1, S30_3, I60_3, P40_4)

of the head to the crown of the head. The distance between the center of the eyes and the crown was measured from the midpoint between the upper and lower limits of the eye, extending to the top of the head. Similarly, the distance from the center of the eyes to the base of the head starts from the same midpoint and reaches down to the base of the head. Horizontal head width was measured between the furthest points of the left and right cheeks, excluding the ears (see Fig. 2). When in doubt, all coders were instructed to take the largest possible measurement. All coders used the same online pixel-ruler tool called rapid-table: https://www.rapidtables.com/web/tools/pixel-ruler.html.

## 3 Results

### 3.1 Inter-rater Agreement

To assess our data's accuracy, a little more than 10% of all bears (sampled over the whole pool of bears regardless of decade; N = 31) were coded by two coders, on each of the three ratios. This double-coding was entirely independent, without discussion between the raters. As pre-registered, we used the Intraclass Correlation Coefficient (ICC, with the following specifications: single score, absolute agreement, one way random model) on each of the three ratios to calculate inter-rater reliability of all 3 ratios. In the pre-registration, we set a threshold of .75.

Among the three measures, Head Roundness (ICC = 0.83) and Forehead Height (ICC = 0.91) surpassed the ICC threshold, confirming their inter-rater reliability. The Eye Size measure got an ICC of 0.71, likely attributable to the smaller size of the eyes, which rendered boundary definitions more susceptible to approximation errors. However, this measurement suggested that an average-score ICC, calculating the reliability not of one measurement but of two averaged measurements, would be sufficiently high. We therefore double coded all bears (not just a sample) for the Eye Size measure, and took the average of the two measurements. This time the ICC was 0.84 (average score, absolute agreement, one way random model).

### 3.2 Statistical Analysis

We tested three predictions: (1) Forehead Height increases with time, (2) Head Roundness increases (i.e., either the ratio increases or it gravitates towards 1, because we do not know whether the heads are cutest when they are more round or larger), and (3) Eye Size increases with time. We conducted three nested regression analyses, one with each measure as the outcome variable. For each model, we included (1) Decade as a fixed effect and (2) Manufacturers as a random effect, allowing us to control for variance attributable to different
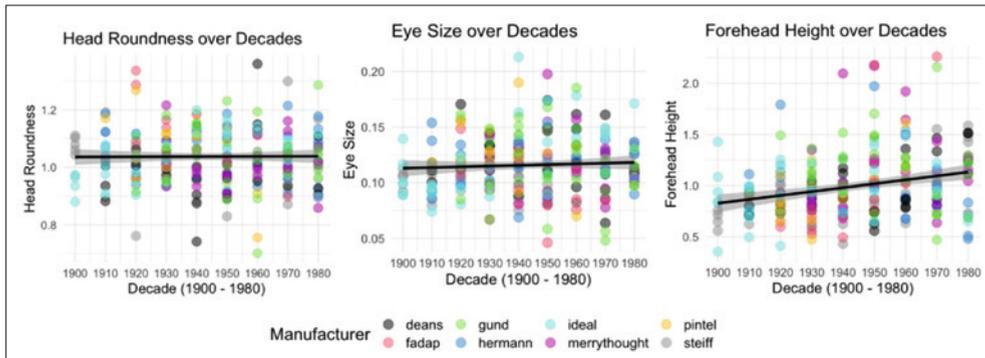
FIGURE 3      The evolution of head roundness, eye size, and forehead height across time

manufacturers. Because we have three tests of the same hypothesis, we performed a Benjamini-Hochberg procedure to correct for multiple testing (i.e., adjusting p-value thresholds based on their rank).

The prediction that the Head Roundness of teddy bears increases with time was rejected: the ratio neither significantly increased ($p$ = .77) nor got closer to 1 ($p$ = .29). The prediction that their Eye Size increases was also rejected ($p$ = .33). Conversely, the prediction that Forehead Height increases with time was confirmed ($p$ = .002). Significance of the latter effect was robust after the Benjamini-Hochberg correction and even after the removal of a specific brand (i.e., Fadap) that showed a steep increase in Forehead Height, thus confirming that the increase in forehead is not driven by one brand. As pre-registered, for both models, we confirmed that linear models fitted better the data than quadratic models (for both models, ΔAIC > 2 with the AIC of the linear model inferior to that of the quadratic model).

## 4        Discussion

This study aimed to investigate whether specific neotenic features associated with cuteness (i.e., eye size, forehead height, and head roundness) have increased in teddy bears over time. Our findings offer mixed results. We replicated one of Hinde and Barden's findings by providing robust evidence for an increase in forehead height over time. This measure, operationalized as the ratio of the distance between the center of the eyes and the crown to the base of the head, showed a progressive increase, confirming our hypothesis that teddy bears' foreheads have become larger. Notably, this ratio evolved from below 1 to above 1 on average, indicating that the eyes have shifted from

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being positioned above to below the midline of the face. Anecdotally, forehead height was deemed by Disney designers to be "very important" (see Fig. 2B).

On the other hand, our attempt to replicate Gould's measure of eye size relative to head size in teddy bears did not bear fruit: we did not find any support for the prediction that eye size relative to head size has increased over time. Finally, our investigation into a new measure of neoteny in cultural artifacts, head roundness, did not yield the expected results. Our analysis did not find a significant increase in the roundness of teddy bears' heads over time, regardless of how we measured it. Such lack of support for two out of three of our predictions could be due to different reasons. First, it could be the case that teddy bears just did not evolve to be cuter. But then, we would have to explain the significant increase in forehead height. Second, it could be that head roundness and eye size are actually not an input of cuteness, or not important ones – but this seems very counterintuitive. Still, other traits (head roundness, precisely, but also softness for instance) could be more important when it comes to toys. Third, it could be that teddy bears are more constrained than we expected them to be (e.g., by technology, material, etc.).

Yet another reason for this result is more intuitive: nobody would anticipate cuteness to escalate indefinitely. For instance, we would not predict that teddy bears' foreheads would keep increasing beyond a certain limit. Rather, we expect to encounter a 'sweet spot' – the most exaggerated stimulus that remains within the limits of what is tractable or appreciated by observers (see, e.g., Gessey-Jones et al., 2021). Our model reveals that Head Roundness has remained remarkably stable over time, consistently a little above 1 (see Fig. 3), indicating that the heads are consistently more wide than they are long. This stability could suggest that the attribute of head roundness has reached its cognitive sweet spot very early in the evolutionary timeline of teddy bears, stabilizing as a result of having attained the maximum and therefore optimal level of exaggeration. This could be tested by comparing teddy bears, not to teddy bears from other time periods, as we did, but to *real-life* bears. The former analysis focuses on the exaggeration *processes* while the latter focuses on the *result* of this process.

Now, we address three limitations of our study that, in our view, can hinder other cultural evolutionary studies similar to this one.

Firstly, there may be *sampling biases*. One of them is success bias: our sample might disproportionately reflect contemporary preferences, as it primarily includes teddy bears that have survived to the present day. Our sampling method aimed to minimize this bias through random selection from different manufacturers, but we cannot guarantee that the books and Internet pages we consulted are not biased. Actually, our study suggests that this bias exists and

does affect empirical findings: while we replicated Hinde and Barden's findings regarding forehead height, the effect magnitude we observed was much lower (the correlation between a bear's forehead height ratio and its estimated date, measured as Spearman's rho, was .25 in our study compared to .59 in Hinde and Barden's study). This discrepancy likely exemplifies the impact of success bias, as Hinde and Barden used teddy bears from an exhibition at the Cambridge Folk Museum in the United Kingdom, where selections likely skewed towards items that better match aesthetic preferences – and we would expect more recent teddy bears to reflect this selection bias to a greater extent, as they are selected from a bigger pool, given the growth of toy production over time.

Second, we encountered *metadata inaccuracy*, both in measurement and metadata. We had to re-code one of our three measures entirely (i.e., anno-tate all Eye Sizes twice) precisely because annotation is subject to errors. But this problem also bears on pre-existing metadata. While we relied on online, user-generated metadata to collect the decade and manufacturer of teddy bears, consultations with a Fadap expert highlighted inaccuracies in such metadata (see Petit, 2015). We corrected such errors for this brand. But we see no reason why this kind of error, attributable to the difficulty of tracing back the history of specific artifacts, would be specific to one brand. We also encountered another interesting problem: we realized that some teddy bear designs were re-published at different times and under different names. This is likely due to resource constraints or the accumulation of unsold goods. In any case, it hinders the study of the evolution of *different* teddy bears across time. Addressing this kind of issue is difficult, and the most feasible solution appears to be increasing the sample size and extending the time period.

Third, there is the problem of *categorization ambiguity*. In our study, the categorical focus on teddy bears alone might restrict our understanding of broader trends in cultural artifacts. If the popularity of teddy bears has declined while other types of animal-shaped stuffed toys (e.g., pandas) have become more prevalent, then a broader analysis encompassing various stuffed toy types should be preferred. It could be the case, for instance, that manu-facturers of teddy bears, upon noticing that their business is endangered by companies making more diverse toys, end up innovating less. This limitation highlights the broader challenge of defining categories when analyzing cul-tural artifacts. Maybe teddy bears are just not the right category to study the impact of cuteness on the cultural evolution of fictional faces; ideally, we may have to study all fictional faces, from comics to animated movies.

The last critical limitation is a problem we may call *function ambiguity*. It is possible that there has been a functional shift in the use of teddy bears across different historical periods. The primary function of such objects might not have always aligned with the playful companions intended for children that

are common today. There is some evidence to suggest that teddy bears were once predominantly viewed as collectibles targeted towards adults rather than as toys for children. This shift in the intended function influences the form or design. If the pressure to make teddy bears appealing as cuddly toys was not a consistent driving force throughout their history, this could explain periods of stagnation in neotenic traits such as head roundness or eye size. Recognizing and accounting for these shifts in function are essential for accurately understanding the cultural evolution of such artifacts.

Considering these factors, future research could benefit from (1) extending the temporal range of the study, (2) expanding the types of cultural artifacts examined, but also from (3) exploring additional measurements that were not included in this study (e.g., head size relative to the body), (4) using more precise measurement tools (e.g., computational measurement), and (5) using more diverse samples (e.g., outside the Western world and market competition). These follow-up studies could help clarify the dynamics of the evolution of cuteness in human cultures.

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## Contribution Statement

QB, ZB, CC, ED, EF, MH, LK, PL, TL, HS, SP, NR, TS, AT, and JY designed and performed the data collection, data coding, and statistical analyses. OM and ED helped supervise the project and wrote a first draft of the manuscript. All authors contributed to the interpretation of the results, provided critical feedback and helped shape the research, analysis and manuscript.

## Conflict of Interest

None.

## Fundings

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