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An explanatory heuristic gives rise to the belief that words are well suited for their referents

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ABSTRACT

The mappings between the words of a language and their meanings are arbitrary. There is, for example, nothing inherently dog-like about the word *dog*. And yet, building on prior evidence (e.g., Brook, 1970; Piaget, 1967), the six studies reported here ($N = 1062$) suggest that both children and (at least to some extent) adults see a special "fit" between objects and their names, as if names were particularly suitable or appropriate for the objects they denote. These studies also provide evidence for a novel proposal concerning the source of these *nominal fit* beliefs. Specifically, beliefs about nominal fit may be a byproduct of the heuristic processes that people use to make sense of the world more generally (Cimpian & Salomon, 2014a). In sum, the present studies provide new insights into how people conceive of language and demonstrate that these conceptions are rooted in the processes that underlie broader explanatory reasoning.

1. Introduction

The words of a language are arbitrary social conventions. In English, for example, we call trees *trees* and cows *cows*, but we could have just as well called trees *cows* and vice versa. There is no inherent reason why particular words refer to particular objects, in English or any other language.[1] However, that may not be exactly how people see this matter. In the present research, we build on prior evidence by Piaget (1967) to suggest that children—and even adults—systematically endorse a belief that words "fit" the objects they denote rather than being arbitrarily paired with them. Further, we test a potential source of these wide-ranging intuitions about word–object fit (or, as we will refer to it, *nominal fit*[2]), suggesting that they are a product of the heuristic processes through which people explain the world. More generally, this work seeks to provide new insights into how people conceive of language and to reveal the deep links between these conceptions and the cognitive processes involved in explanation and understanding. In the first section below, we briefly review previous evidence regarding beliefs about nominal fit. We then detail our proposal concerning how these beliefs arise and describe six studies that investigated this proposal.

1.1. Prior evidence on beliefs about nominal fit

According to Piaget (1967), beliefs about nominal fit represent an intermediate stage in children's reasoning about words (see also Brook, 1970; Ianco-Worrall, 1972; Vygotsky, 1962).[3] Early in development, children assume a word to do more than just pick out an object; they also believe that the word matches its referent at some level. This belief that words have a special match with the features of their referents was suggested by children's reasoning about why objects have the names they do (Piaget, 1967; see also Brook, 1970; Ianco-Worrall, 1972; Vygotsky, 1962). For instance, the children interviewed by Piaget thought that the sun is called *sun* not because of arbitrary conventions established in the past but "because it shines" or "because it is all red"; or, to take another example, the mountains are called *mountains* "because they are all white" (Piaget, 1967, p. 84). The underlying intuition here is that an object has the name it does because this name appropriately captures how

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[1] Phonetic symbolism, the phenomenon whereby certain sounds have non-arbitrary links to certain meanings (e.g., Maurer, Pathman, & Mondloch, 2006), is more of an exception than a general rule for how the vocabulary of a language maps onto its referents.

[2] This term is a play on Piaget's (1967) *nominal realism*. The latter is broadly used to refer to a number of beliefs about a non-arbitrary link between words and objects (including, for example, a belief that names are features of the objects or that names have causal effects on the world [see Rozin, Millman, & Nemeroff, 1986; Rozin, Markwith, & Ross, 1990]). For this reason, we introduced the term *nominal fit* to pick out specifically the phenomenon studied here—namely, a belief that words are particularly suitable for their referents.

[3] Piaget labeled the idea that names fit their referents *logical realism*. Since the term *logical realism* is relatively opaque, we prefer our own *nominal fit*.

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this object is constituted—names function almost like descriptions (see Russell, 1905). Because they assume nominal fit, children also fail to realize that the names of objects could have been different than they currently are. For example, children claimed that the sun could not have been called *moon* and vice versa because "the sun makes it warm and the moon gives light" or because "the sun shines brighter than the moon" (Piaget, 1967, p. 81).

Some of this evidence, however, was subsequently criticized on methodological grounds. For example, Markman (1976) pointed out that Piaget's questions often presumed a sophisticated meta-level understanding of words as objective units of language. Reasoning about words *as words* may be difficult for young children (e.g., Osherson & Markman, 1975; Papandropoulou & Sinclair, 1974), and thus children may have answered Piaget's questions as if they were about the referents instead (see also Bialystok, 1987). When children claimed, for instance, that the sun could not have been called *moon*, they might have been doing so because they were reasoning about the referent objects rather than about the names of these objects (as if they had been asked whether the sun is the same thing as the moon). Another prominent criticism concerns the fact that some of Piaget's questions required counterfactual reasoning (e.g., "could we have called the sun *moon*?"), which might have been too taxing for children's limited cognitive resources (e.g., Rosenblum & Pinker, 1983). Without appropriate scaffolding, young children might have failed to understand the hypothetical scenario, believing instead that they were being asked about the current names of the relevant objects (e.g., "do we call the sun *moon*?").

While reasonable, these criticisms are not sufficient to undermine the claim that children see words as being suited for their referents. Note, for instance, that children give answers that suggest they believe in nominal fit well into the elementary school years (e.g., Ball & Simpson, 1977; Brook, 1970; Piaget, 1967), by which point they have fairly mature metalinguistic awareness of words as elements of language (e.g., Doherty, 2000; Karmiloff-Smith, Grant, Sims, Jones, & Cuckle, 1996) and well-developed counterfactual reasoning skills (e.g., Beck, Robinson, Carroll, & Apperly, 2006; German & Nichols, 2003; Harris, German, & Mills, 1996).

Although existing evidence for intuitions about nominal fit cannot be fully explained by low-level alternatives, research on this topic has been largely dormant in the past few decades, preventing progress on understanding these intriguing beliefs. Most notably, we know very little about their source: Why would children believe so firmly, and for so long, in a fit between names and objects, especially given that this fit is illusory? Here, we test the proposal that these beliefs are a product of the broader processes by which people make sense of the world across development. Aside from yielding new insights into a decades-old phenomenon that has not yet received a satisfactory account, this research contributes more broadly to our understanding of the ways people conceive of language. By demonstrating that people's intuitive understanding of the relation between words and objects is continuous with their understanding of non-linguistic phenomena, these studies forge new links between the research on explanatory reasoning and the work on metalinguistic conceptions, perhaps spurring new interest in this often-overlooked topic.

1.2. Nominal fit intuitions are a product of the heuristic processes underlying explanation

The most common and effective route to understanding a phenomenon is to explain it (e.g., De Regt, 2013; Hempel, 1965; Keil, 2006; Lombrozo, 2012), and therefore people's understanding of the relationship between words and their referents may likewise be rooted in the explanations they generate for these mappings. In other words, attending to the mechanisms that underlie everyday explanations might provide insight into the source of people's nominal fit intuitions.

To characterize these mechanisms, it is useful to first consider the fact that people often have the impression of effortlessly understanding the world they inhabit rather than being stumped at every turn. And yet, explaining is far from a trivial task—it has taken us thousands of years to adequately explain even the most basic aspects of our world, such as that things fall to the ground when unsupported. The contrast between the formal difficulty of the explanatory task and the cognitive ease with which we seem to solve it suggests that, in many everyday circumstances, explaining proceeds *heuristically* (Cimpian, 2015; Cimpian & Salomon, 2014a, 2014b; see also Evans, 2006; Kahneman, 2011; Shah & Oppenheimer, 2008; Stanovich & West, 2000; and others). That is, rather than systematically seeking the best explanation for a fact, people might often generate a quick, approximate judgment based on information that comes to mind readily. The heuristic nature of this explanatory process has important consequences for the content of its outputs. In particular, if the search for an explanation starts with the retrieval of information that is quickly called to mind about the observation to be explained (the explanandum), this process is likely to oversample facts about the inherent, constitutive features of the entities in the explanandum. The inherent features of an entity are roughly those that, if changed, would lead to a change in the entity itself. For example, replacing the vitamin C in a lemon with another substance would cause real changes to it (and thus *has vitamin C* qualifies as an inherent feature). In contrast, changing the lemon's owner would not—by itself—cause the lemon to change (and thus facts such as *belonging to Jennifer* are not inherent). Importantly, inherent facts are often central to our semantic representations of objects in the world and are thus highly accessible during reasoning (e.g., Hussak & Cimpian, 2014; Kahneman & Tversky, 1973; McRae, Cree, Seidenberg, & McNorgan, 2005; McRae, de Sa, & Seidenberg, 1997). In turn, this bias toward inherence in the information retrieved from memory has consequences for downstream processing, restricting the range of explanations that are ultimately constructed.[4]

Indeed, there is already considerable evidence for the presence of such an *inherence heuristic* in explanation across development (e.g., Cimpian & Markman, 2009, 2011; Cimpian & Steinberg, 2014; Hussak & Cimpian, in press; Salomon & Cimpian, 2014). But how might this inherence heuristic promote intuitions about nominal fit? To start, it is worth noting that a phenomenon explained inherently is thereby understood as arising simply as a product of the entities that make it up, which is also likely to make this phenomenon appear natural and sensible rather than arbitrary (Cimpian, 2015; Cimpian & Salomon, 2014a, 2014b; Cimpian & Steinberg, 2014; Hussak & Cimpian, in press; Tworek & Cimpian, 2015). For example, if one explains why stop signs are red using the fact that red is a bright, attention-getting color, then—in light of this explanation—the pairing of stop signs and red might also seem natural, even appropriate. This explanation suggests that red is a *suitable* color for stop signs, perhaps even the color that stop signs *should* be. In other words, explaining an observation in inherent terms often licenses further, value-laden judgments about it (for a similar argument concerning the link between explanation and normativity, see Prasada & Dillingham, 2006). This is the rationale for our proposal of a link between the inherence heuristic and beliefs about nominal fit. We hypothesize that, when children attempt to understand why certain objects have the names they do, they often rely on the inherence heuristic and, as a result, they arrive at explanations couched in terms of the highly accessible inherent features of the referents (e.g.,

[4] However, this heuristic process can also output non-inherent explanations, provided that the relevant facts are easily accessible in memory.

their appearance) or the names (e.g., their sound). In turn, these inherent explanations further suggest to children, and perhaps even to adults, that words are appropriately paired with their referents. If children make sense of why, say, trees are called *trees* by invoking some feature of these objects (e.g., because they have branches)—as if the name described them—then this name might also seem fitting and sensible to children rather than an arbitrary convention that could have easily been otherwise.

Initial support for this proposal can be found in children's unambiguously inherent explanations to Piaget's (1967) questions about why objects have the names they do (see also Brook, 1970; Rosenblum & Pinker, 1983). For example, children said the sun is called *sun* because of its brightness, its heat, or its color, and they also thought that it could not have any other name. Also consistent with our argument, some evidence suggests that children's failure to understand words as arbitrary conventions is strongly correlated with their failure to understand other regularities as conventions (e.g., rules of etiquette such as eating with utensils rather than with one's hands; Lockhart, Abrahams, & Osherson, 1977).[5] These tight relationships are exactly what we would expect if children's explanations for a broad range of linguistic and non-linguistic regularities relied on the same fundamental cognitive process (the inherence heuristic; Cimpian & Steinberg, 2014).

1.3. The present research

Building on this preliminary evidence, the six studies reported in the present manuscript provide the first direct test of our proposal that nominal fit beliefs are rooted in an inherence heuristic in explanation. These studies investigated three predictions of our proposal. First, we expected that the extent to which children endorse beliefs in nominal fit would be predicted by the extent to which they rely on the inherence heuristic (Study 1). Second, because the inherence heuristic is influential beyond childhood (Cimpian & Salomon, 2014a, 2014b; Hussak & Cimpian, in press; Salomon & Cimpian, 2014), we expected to find evidence for the same relationship in adults' reasoning as well, even though their intuitions about nominal fit should obviously be weaker than children's and thus show less variability (Studies 2–5). Moreover, the relationship between endorsement of nominal fit beliefs and reliance on the inherence heuristic should hold even when adjusting for a number of other individual differences that could in principle provide alternative explanations for it (e.g., fluid intelligence, motivation for effortful thought, familiarity with foreign languages). Finally, we predicted that an experimental manipulation that temporarily alters the extent to which adults rely on inherence-based intuitions should have downstream effects on their nominal fit beliefs (Study 6). Across these six studies, we found consistent support for the proposal that an inherence heuristic in explanation gives rise to the intuition that words are well suited for their referents.

2. Study 1

In the first study, we investigated whether children's nominal fit beliefs are predicted by their reliance on the inherence heuristic, as proposed. We focused on a broad age span in this study (children between the ages of 4 and 7) to ensure that children's beliefs about nominal fit would show sufficient variability.

2.1. Methods

2.1.1. Participants

Sixty-four children (half girls and half boys) were recruited from a small city in the Midwestern US (age range = 4.18–7.96 years, $M = 5.89$, $SD = 1.15$). Although demographic information was not formally collected, the children were socioeconomically diverse, and most were European American.

2.1.2. Procedure

We asked children two sets of questions: one set measured their nominal fit beliefs and the other measured their use of the inherence heuristic. The order of the two sets of questions was counterbalanced across participants. Each set was accompanied by pictures to maintain children's attention.

2.1.3. Measures

2.1.3.1. Nominal fit. Nominal fit is the idea that the words we use are, at some level, *right* or *fitting*, and thus that no other word–object pairings would have worked as well. To measure endorsement of this idea in a child-friendly way, we presented children with brief vignettes that asked whether familiar objects (e.g., zebras) could have had another name or whether they *had* to have the name they do, which might indicate that children believe there is a special fit between objects and their assigned names. Below is the script for one of the vignettes:

> Ok, so a long time ago, people didn't have a name for this kind of animal. [*The experimenter points to a picture of a zebra.*] They didn't have a name for it, and they wanted to come up with one. How did they do that? When people were first coming up with a name for this animal, did they have to call it a *zebra*, or could they have called it something else, like a *diby* or a *peara*?

The task included three other vignettes identical to that above, except about different words: *giraffe*, *lion*, and *bear*. Each trial used a different pair of novel words as alternatives to the conventional word. The order of the two response alternatives (i.e., that the object had to have that name vs. that the name could have been different) was constant across trials for any one child but was counterbalanced across subjects. The order of the four vignettes was also counterbalanced.

This measure was constructed so as to avoid some of the concerns that have been raised about previous measures in the literature. First, we sought to minimize the possibility that nominal fit responses would stem from a misunderstanding of the question as being about the object, not the word (e.g., Osherson & Markman, 1975). Our task blocked this sort of misunderstanding by making it very explicit that we were asking about the *link* between the name and the object ("They didn't have a name for it, and they wanted to come up with one. How did they do that?"). Second, our task scaffolded children's understanding of the critical question about the hypothetical alternative names by first setting the stage for this question ("Ok, so a long time ago, people didn't have a name for this kind of animal…"), thereby minimizing the difficulties associated with counterfactual reasoning (Rosenblum & Pinker, 1983).

In addition, because the two response alternatives were complex, we allowed children to respond non-verbally by pointing to one of two body parts. For example, children could touch their chin to select one alternative and their ear to select the other. The mapping of the two gestures to the two response alternatives was

[5] Our argument does not conflict with the developmental literature on children's awareness of the *conventionality* of words (e.g., Buresh & Woodward, 2007; Clark, 1988; Diesendruck, 2005; Diesendruck & Markson, 2011; Graham, Stock, & Henderson, 2006; see also Cimpian & Scott, 2012). In this literature, conventionality is operationalized as an understanding that a word is widely known— a different dimension of conventionality than the one we are investigating here. Conventionality is a multifaceted construct, and we expect some facets of it (i.e., words are widely known) to be much easier to grasp than others (i.e., words are arbitrary).

counterbalanced across children. To minimize the memory load, the experimenter always reminded children which gesture goes with which answer just before asking them to respond. This method allowed children to answer without having to verbally articulate the option with which they agreed. (For a previous use of this procedure, see Cimpian & Park, 2014.)

Children's responses were coded as 1 if they selected the nominal fit option (e.g., they had to call it a *zebra*) and as 0 if they selected the other option. We averaged children's scores across the four trials to derive a composite score that could range from 0 to 1, with higher scores indicating stronger intuitions about nominal fit.

2.1.3.2. Inherence heuristic. The measure of children's reliance on the inherence heuristic was borrowed from a prior series of studies investigating the developmental trajectory of this explanatory process (Cimpian & Steinberg, 2014). None of the items in this measure concerned words; rather, they pertained to non-linguistic aspects of the world (e.g., the fact that coins are round). For each item, children were asked three types of questions. The first type measured children's explanatory preferences. Children were presented with inherent explanations (e.g., coins are round "just because they are coins") and extrinsic explanations (e.g., coins are round "just because people thought it might be a nice idea") and were asked to evaluate them on a 4 point scale ("really not right" = 1, "a little not right" = 2, "a little right" = 3, "really right" = 4). The second and third types of questions tapped intuitions that follow from inherence-based explanations. If a particular pattern is explained in inherent terms (e.g., some feature of coins explains why they're round), one might also reasonably assume that this pattern *cannot be changed* and is *temporally stable*. Thus, the second type of question assessed whether children thought it would be okay to change the relevant pattern (e.g., "Imagine if people wanted coins to be a different shape, and everyone agreed that they wanted coins to be a different shape. Would it be okay to make a change so that coins are not round, or would it not be okay?"). Children made their answers on a scale from 1 ("okay") to 4 ("really not okay"). Finally, the third type of question assessed whether children thought the relevant pattern had always been and would always be as it currently is (e.g., "Do you think coins have always been round, even way back when the first ever coin was made?"). Children's "yes" answers were scored as 1, and their "no" answers were scored as 0.

Each of the questions was asked about three items (coins are round; birthday cakes have candles; and school buses are yellow). The order of these items was counterbalanced, as was the order of the three types of questions. Children's answers were standardized within each question and then combined into an inherence heuristic composite score (α = .63), with higher scores indicating greater reliance on the output of this explanatory process.

2.1.3.3. Control variables. To address potential alternative explanations for the hypothesized relationship between nominal fit beliefs and inherence-based explanations, our analyses included two control variables. First, both nominal fit beliefs and use of the inherence heuristic might covary with *children's age*. The nominal realism literature has consistently found a developmental trend away from realist reasoning about words (e.g., Brook, 1970; Osherson & Markman, 1975; Piaget, 1967). Similarly, use of the inherence heuristic has been shown to decline somewhat with age (Cimpian & Steinberg, 2014). Therefore, it is possible that the two variables of interest would correlate simply because they both happen to decrease with age (and not because beliefs about the suitability of words are rooted in an inherence heuristic in explanation, as we claimed). We therefore adjusted for children's exact chronological age in our analyses. Note that this adjustment can also account, at least to some extent, for the potential influence of other variables that are strongly age-linked (e.g., cognitive ability, language skill).

Second, experience with multiple languages is usually accompanied by more sophisticated reasoning about the arbitrariness of words (e.g., Bialystok, 1987; Cummins, 1978; Ianco-Worrall, 1972; Rosenblum & Pinker, 1983). This factor might also affect the output of the inherence heuristic, insofar as children with a wider variety of linguistic and cultural experiences might have a wider variety of information (including extrinsic information) to draw on when generating an explanation (e.g., Kinzler & Sullivan, 2014). To address this potential confound, we measured children's *exposure to multiple languages* by asking parents whether they spoke any languages other than English to their child at home. Children's score on this dimension was the number of languages other than English that they had been exposed to (M = .19, SD = .43, range = 0–2).

2.1.4. Data analyses

The dependent variable (i.e., nominal fit beliefs) in this and all subsequent studies was non-normally distributed, as indicated by Shapiro–Wilk tests. We took two steps to accommodate the nature of these data: First, we used bootstrapping techniques (1000 replications) to derive standard errors, p values, and bias-corrected and accelerated (BCa) 95% confidence intervals for the multiple regression estimates reported in all studies. Second, we used nonparametric, rank-based tests (namely, Mann–Whitney U) for any between-group comparisons (see Study 6).

2.2. Results and discussion

If our proposal is correct, children's reliance on inherence-based intuitions should predict unique variance in their nominal fit beliefs, above and beyond their chronological age and their exposure to multiple languages. Consistent with this hypothesis, children's inherence heuristic composite scores significantly predicted their nominal fit scores in a regression analysis controlling for age and multilingualism, b = .26 [.15, .38], SE = .05, p < .001 (see Appendix A for the full correlation matrix and Appendix B for the means). The other outcomes of this regression were consistent with prior work: First, nominal fit beliefs decreased with age, b = −.13 [−.19, −.06], SE = .03, p < .001. Second, exposure to multiple languages was associated with lower endorsement of nominal fit beliefs, b = −.19 [−.31, −.07], SE = .07, p = .006.

It is worth noting that the results above were replicated when we used just the questions that assessed explanations per se as a measure of children's reliance on the inherence heuristic (that is, leaving out the questions about change and stability). Most importantly, this narrower measure of reliance on the inherence heuristic still predicted children's nominal fit beliefs, b = .17 [.07, .28], SE = .05, p < .001. Thus, the most direct measure of children's explanatory preferences also predicted unique variance in their beliefs about the fit between names and objects.

To conclude, these findings support our first prediction: namely, that children's use of the inherence heuristic in making sense of the world predicts their belief that words and their referents are suitably connected.

3. Study 2

Study 2 tested the second prediction of our account—that reliance on the inherence heuristic should be correlated with endorsement of nominal fit beliefs *even in adults*. This prediction follows directly from our argument that nominal fit beliefs are the consequence of an inherence heuristic in explanation—a heuristic that is influential in adults' reasoning as well, not just children's (Cimpian & Salomon, 2014a, 2014b; Hussak & Cimpian, in press; Salomon & Cimpian, 2014). Note, however, that this is a conservative test of our proposal because intuitions about nominal fit are likely to be (at best) weak among literate, educated adults. In fact, prior theories have explicitly maintained that intuitions about nominal fit are just an intermediate stage in the development of children's metalinguistic knowledge (e.g., Brook, 1970; Piaget, 1967) and should thus be absent from adults' reasoning altogether.

Additionally, we explored another possible interpretation of the predicted relationship: Perhaps nominal fit beliefs and inherence-based explanations are related simply because they co-occur in people with less complex cognitive styles (e.g., Stanovich, 1999; Stanovich & West, 2000). That is, individuals who—regardless of their cognitive abilities—prefer simple, black-and-white judgments or dislike effortful cognitive activity might be more likely to adopt both nominal fit beliefs and heuristic explanations, which would, in and of itself, give rise to a correlation between these two types of judgments. We explored this possibility by statistically adjusting for two widely used measures of cognitive style: the Need for Closure Scale (Kruglanski, Webster, & Klem, 1993) and the Need for Cognition Scale (Cacioppo, Petty, & Kao, 1984). We expected that participants' explanatory preferences would predict unique variance in the extent to which they endorse beliefs about word–referent fit, above and beyond the two measures of cognitive style.

3.1. Methods

3.1.1. Participants

Undergraduate students from a large US university ($N = 126$; $M_{age} = 20.6$ years; 72% female) participated in this study.[6] Approximately half of the students completed the study online, whereas the other half completed it in a computer lab. An additional participant was tested but excluded from the final analyses for failing the catch items in the Inherence Heuristic Scale (see below).

3.1.2. Measures

3.1.2.1. Nominal fit. We developed an eight-item nominal fit measure ($\alpha = .65$) to capture adults' intuitions concerning whether words are particularly suitable or appropriate for their referents (see Table 1 for sample questions). Participants' average rating across the eight items served as a dependent variable in our analyses. Unsurprisingly, average endorsement of nominal fit was fairly low overall ($M = 2.14$ on a 1–7 scale, $SD = 0.85$, range = 1.00–4.38).

Participants were also asked to justify their scale ratings. These justifications provided a means of assessing the construct validity of our measure. If participants' scale ratings truly tap into their nominal fit beliefs, then these beliefs should also be detectable in their open-ended justifications. The justifications were coded independently by two researchers (both of whom were blind to participants' scale ratings) for the extent to which they expressed beliefs about the fit between words and referents (1 = no nominal fit; 2 = unclear; 3 = nominal fit). Inter-rater agreement was excellent (kappa = .82).[7] Coders' ratings of these open-ended justifications correlated highly with participants' scale ratings, $r(124) = .72$, $p < .001$, which provides evidence for the construct validity of the scale measure. That is, participants' scale ratings seem to genuinely capture the extent to which they view word–referent pairings to be non-arbitrary.

In Table 2, we list a sample of the justifications that revealed a belief in nominal fit. Overall, 66.7% of participants provided at least one such justification. To take an example, when asked whether *yaroo* could have been a suitable name for what is now called a *zebra*, one participant reasoned that, "Maybe it would work, but *zebra* sounds more suitable to me. Maybe it's because of the stripes."

Finally, to test whether our eight items indeed measure a *single* latent construct (namely, a belief in nominal fit), we conducted a confirmatory factor analysis using a correlated uniqueness model that allowed the error terms of similarly-structured items to correlate (Kenny & Kashy, 1992; Marsh, 1989). The hypothesized one-factor model provided a good fit to the data ($\chi^2[8, N = 126] = 12.10$, $p = .147$; RMSEA = .064; SRMR = .039; CFI = .968), consistent with the claim of a single underlying dimension (see Hu & Bentler, 1999, for additional information about interpreting fit indexes).

3.1.2.2. Inherence heuristic. The Inherence Heuristic Scale consisted of 15 randomly ordered items that assessed participants' tendency to rely on inherent explanations (e.g., "It seems natural that engagement rings typically have diamonds"). Extensive evidence concerning the construct validity, internal consistency, and factor structure of this scale can be found in Salomon and Cimpian (2014). The scale also included four catch items (e.g., "It seems right to kill people for fun") designed to screen out participants who were inattentive. Participants who failed two or more of these items (e.g., agreeing that it is right to kill people for fun) were excluded from the final analyses ($n = 1$). For this scale and the two described below, participants marked their answers on a scale from 1 (disagree strongly) to 9 (agree strongly).

3.1.2.3. Need for Closure. The Need for Closure Scale consisted of 42 randomly ordered statements that assessed participants' preference for order, simplicity, and quick, unambiguous judgments (e.g., "I usually make important decisions quickly and confidently"; Kruglanski et al., 1993).

3.1.2.4. Need for Cognition. The Need for Cognition Scale consisted of 18 randomly ordered statements that assessed participants' motivation to engage in effortful cognitive activity (e.g., "I find satisfaction in deliberating hard and for long hours"; Cacioppo et al., 1984).

3.2. Results and discussion

In line with our proposal, participants' scores on the Inherence Heuristic Scale were a significant predictor of their nominal fit beliefs even when adjusting for the two measures of cognitive style, $b = .24$ [.09,.39], $SE = .07$, $p = .002$ (see Table 3 for full regression results, Appendix A for the correlation matrix, and Appendix B for the means). Neither measure of cognitive style uniquely predicted participants' nominal fit scores. Together, these findings suggest it is unlikely that the relationship between nominal fit beliefs and inherent explanations is an artifact of their co-occurrence in individuals with less complex cognitive styles. Rather, these results are more compatible with our proposal, according to which beliefs about an inherent link between names and objects are simply an instantiation of a broader reliance on inherent explanations in making sense of the world.

[6] Due to a programming error, demographic information was collected from only 78 participants.

[7] Twenty subjects were used for training the second coder, and thus reliability was calculated over 106 participants. We used a prevalence- and bias-adjusted kappa formula that was designed for ordinal coding scales (see Byrt, Bishop, & Carlin, 1993).

Table 1
Sample items from the nominal fit measure used in Study 2.

Sample question #1:
Consider long ago when people discovered the kind of animal above [*referring to a picture of a lion*] and decided to give it a name. In English, we call it a "lion." Do you think there is something particularly appropriate about this name, or could we have just as easily called this animal something else?
Answer scale: 1 (this name is particularly appropriate) to 7 (we could have easily called this animal something else)

Sample question #2:
Think back to a time long ago when people discovered the kind of animal above [*referring to a picture of a pig*] and decided to give it a name. In selecting this name, how many suitable options did they have?
Answer scale: 1 (only a few suitable options) to 7 (countless suitable options)

Sample question #3:
The name "yaroo" would have been a suitable name for this kind of animal [*referring to a picture of a turtle*].
Answer scale: 1 (strongly disagree) to 7 (strongly agree)

Sample question #4:
Imagine the word "cow" was not an English word. That is, imagine we called cows something else in English and the word "cow" didn't mean anything. Now imagine that at some point in the future English speakers decided to use the word "cow" for a kind of thing that didn't yet have a name. In selecting a kind of thing to call "cow," how many suitable options did they have?
Answer scale: 1 (only a few unnamed things would be suitable) to 7 (pretty much any unnamed thing would be suitable)

Note. Studies 3–5 used identical questions, except about artifact names (e.g., "bottle").

Table 2
Sample justifications from the nominal fit measure (Studies 2–5).

... the long "a" in "giraffe" appears fitting for the long neck.
Only a few different words could possibly describe a glove.
"Yaroo" is two syllables and doesn't really fit.
I feel like the name fits the object better than anything else would.
I feel like turtle was given its name for biological reasons and "yaroo" seems just arbitrary.
I think it's a fitting name ["giraffe"] although other names could be used, but I believe the way the word is pronounced it gives you a feeling of being stretched out like the giraffe's neck.
The [novel] name doesn't fit the form and function of a chair, or anything you sit on for that matter.
I think it might be difficult [to call a bowl "a fork"] because the word "bowl" kind of describes the "o" shape of the object. The fork doesn't.
It is called a "fork" because of the prongs on it, so [using the word "fork" for] a bowl would take away from its real name.
"Yaroo" doesn't give a sound like "chair," to imply what you do with it.
It [the novel word] doesn't really match the object.
... "bowl" does have some connotations due to how the mouth moves to make the sound.
"Yaroo" doesn't seem to fit the name for a chair. It just sounds wrong to me.
The name sounds fitting for what it's meant to do.

Note. Quotes were added to participants' justifications where needed to clarify when they were referring to the word or to the object.

Table 3
Regression analyses predicting participants' nominal fit beliefs in Studies 2–4.

Study	Predictor	*b*	*SE*	BCa 95% *CI*	*p*
2	Inherence Heuristic	.24	.07	[.09,.39]	.002
	Need for Closure	.07	.09	[−.12,.24]	.452
	Need for Cognition	.06	.06	[−.09,.18]	.352
	R^2 total	.11			
	F	4.81			
	N	126			
3	Inherence Heuristic	.23	.08	[.06,.41]	.004
	Raven's Progressive Matrices	−.08	.04	[−.16,−.01]	.022
	Creative Personality Checklist	−.01	.02	[−.05,.03]	.805
	R^2 total	.16			
	F	7.21			
	N	122			
4	Inherence Heuristic	.27	.09	[.09,.45]	.003
	Counterfactual Thinking	−.10	.04	[−.18,−.02]	.029
	Multilingualism	.01	.04	[−.06,.13]	.780
	R^2 total	.15			
	F	7.01			
	N	122			

Note. BCa = bias-corrected and accelerated.

4. Study 3

Study 3 was modeled on Study 2, with two main changes. First, because animal names are occasionally non-arbitrary (e.g., onomatopoeia such as *cuckoo* or *chickadee*), we revised the nominal fit measure so that it asked about artifact names instead (e.g., *fork*). This change should provide a more conservative estimate of participants' nominal fit beliefs, as well as increase the generalizability of our conclusions.

Second, we included a new pair of control variables, which can address two more alternative explanations for our findings so far: Perhaps nominal fit beliefs and inherent explanations are related just because they happen to co-occur in individuals who (1) have lower fluid intelligence, or (2) are less creative. These individuals may be less able to imagine the myriad ways in which our words could have been different, and, independently, they may also be more likely to explain heuristically. In contrast to this alternative, we predict that the relationship between nominal fit and inherence will be present even when accounting for these cognitive variables.

4.1. Methods

4.1.1. Participants

Participants were recruited from Amazon's Mechanical Turk ($N = 122$; $M_{age} = 36.2$ years; 51% female). In this and all subsequent studies, Mechanical Turk participants were paid $0.75. An additional eight participants were tested but excluded from the sample because they failed the catch items in the Inherence Heuristic Scale.

4.1.2. Measures

The measures of inherent reasoning and nominal fit were administered as in Study 2, except that the nominal fit measure asked about artifacts instead of animals. As in Study 2, two researchers independently coded participants' justifications for their scale ratings on the nominal fit measure (kappa = .81). The codes assigned to these justifications were again strongly correlated with participants' scale ratings, $r(120) = .57$, $p < .001$, suggesting that the latter truly tap into participants' beliefs about the word–object link. Overall, 38.5% of participants provided at least one open-ended justification that indicated a belief in nominal fit.

4.1.2.1. Fluid intelligence. We used a subset of Raven's Standard Progressive Matrices (Raven, 1960), a standard test of fluid intelligence. Participants were required to solve 12 pattern completion problems. The problems were presented for 1 min each, in increasing order of difficulty. Scores were calculated by summing the number of correct responses.

4.1.2.2. Creativity. Participants completed Gough's (1979) Creative Personality Checklist, a widely used measure of creativity. Participants indicated which of 30 personality traits described them. Scores were calculated by adding the number of selected traits that had previously been found to correlate with creative achievements (e.g., "original") and subtracting the number of selected traits negatively associated with such achievements (e.g., "cautious"). Trait order was randomized.

4.2. Results and discussion

The findings were again consistent with our second prediction that adults' inherent explanations would be related to their nominal fit beliefs. Participants' scores on Inherence Heuristic Scale significantly predicted their nominal fit beliefs in a regression analysis that adjusted for fluid intelligence and creativity, $b = .23$ [.06,.41], $SE = .08$, $p = .004$ (see Table 3 for full regression results, Appendix A for the correlation matrix, and Appendix B for the means). These findings suggest that intelligence and creativity cannot account for the relationship between people's explanatory tendencies and their endorsement of beliefs about word–object fit. Instead, the results of this study provide more evidence supporting our claim that the inherence heuristic is a source of nominal fit intuitions.

5. Study 4

Study 4 provided a further test of our second prediction (namely, that adults' reliance on heuristic explanations would be related to their belief in the non-arbitrariness of words). Additionally, Study 4 explored the possibility that this predicted relationship may be due to individual differences in either (1) counterfactual thinking (which might suppress both nominal fit beliefs and inherent explanations; e.g., Salomon & Cimpian, 2014; Stanovich & West, 1997) or (2) exposure to multiple languages, and by extension, multiple cultures (which, as argued before, could likewise lower both variables of interest; e.g., Bialystok, 1987; Kinzler & Sullivan, 2014).

5.1. Methods

5.1.1. Participants

Participants were recruited from Amazon's Mechanical Turk ($N = 122$; $M_{age} = 36.0$ years; 57% female). An additional seven participants were tested but excluded from the sample because they failed the catch items in the Inherence Heuristic Scale ($n = 6$) or because they indicated during debriefing that they had not paid attention to the survey ($n = 1$).

5.1.2. Measures

The measures of nominal fit beliefs and inherent explanations were administered exactly as in the preceding study (Study 3). Inter-coder agreement for participants' open-ended justifications on the nominal fit measure was again high (kappa = .72), as was the correlation between this coding and participants' scale responses, $r(120) = .68$, $p < .001$. Overall, 51.6% of participants provided at least one open-ended justification that indicated a belief in nominal fit.

5.1.2.1. Counterfactual thinking. To measure counterfactual thinking, we used a two-item scale from Stanovich and West (1997; e.g., "My beliefs would not have been very different if I had been raised by a different set of parents" [reverse-scored]). Responses to each item were recorded on a scale from 1 (disagree strongly) to 9 (agree strongly).

5.1.2.2. Multilingualism. We first asked participants how many languages other than English they were familiar with. Next, participants rated how fluent they were in each of these languages on a scale from 1 (limited familiarity [e.g., a year of instruction in school]) to 5 (native speaker [learned from birth]). Participants' multilingualism scores were then calculated by adding up their fluency ratings across however many languages they were familiar with, other than English ($M = 2.07$, $SD = 2.70$, range = 0–17).

5.2. Results and discussion

The results mirrored those from Studies 1–3. Once again, participants' tendency to rely on inherence-based intuitions was a significant, unique predictor of their beliefs in the non-arbitrariness of words, even when controlling for their counterfactual thinking and their exposure to multiple languages, $b = .27$ [.09,.45], $SE = .09$, $p = .003$ (see Table 3 for full regression results, Appendix A for the correlation matrix, and Appendix B for the means). These results reinforce our argument that the heuristic processes people rely on to explain the world in general also underlie how they make sense of the mapping between words and objects.

6. Study 5

Unlike Study 1, the three adult studies so far (Studies 2–4) did not measure participants' endorsement of actual inherent explanations. Rather, these studies tapped intuitions that follow from inherent explanations (e.g., "It seems natural that engagement rings typically have diamonds"; Salomon & Cimpian, 2014). For a more direct assessment, in Study 5 we presented participants with two sets of explanations that explicitly appealed to inherent features (see Table 4): a set that consisted of inherent explanations about a wide range of non-linguistic facts (which we termed *Inherence–Global*) and a set that focused more narrowly on the linguistic relation between names and objects (which we termed *Inherence–Language*). Using these new measures, we tested whether the global tendency to explain the world inherently is accompanied by a more specific tendency to explain the mapping between words and objects inherently, which then promotes intuitions about nominal fit. In the context of a mediation model, we should thus see a significant indirect path linking participants' scores on the Inherence–Global scale with their endorsement of nominal fit via their scores on the Inherence–Language scale (see the diagram in Fig. 1).

For a stronger test of this prediction, we added two covariates to the mediation model. The first was a version of the Cognitive Reflection Task (CRT; Frederick, 2005)—a widely used measure of heuristic thinking. We predicted that our measures of heuristic explanations will account for unique variance in nominal fit beliefs, above and beyond participants' general propensity for heuristic thinking (as measured by the CRT). The second covariate assessed the extent to which participants view randomness and chance as influencing their lives (Levenson, 1981). Perhaps a tendency to underestimate the influence of chance leads people to explain the world by appealing to inherent (rather than extrinsic) facts, as well as to endorse beliefs about nominal fit. Contrary to this alternative, we predicted that the hypothesized path linking inherent explanations with nominal fit beliefs will remain significant even when adjusting for participants' understanding of chance.

6.1. Methods

6.1.1. Participants

Participants were recruited from Amazon's Mechanical Turk ($N = 128$; $M_{age} = 33.9$ years; 54% female).[8] An additional 13 participants were tested but excluded from the sample because they failed more than one catch item across the scales (see below).

6.1.2. Measures

Participants completed five scales in randomized order. The measure of nominal fit beliefs was administered exactly as in Studies 3 and 4 (and thus focused on artifact names). Inter-coder agreement for participants' open-ended justifications on the nominal fit measure was again high (kappa = .84), as was the correlation between this coding and participants' scale responses, $r(126) = .65$, $p < .001$. Overall, 46.1% of participants gave at least one nominal fit explanation in their open-ended justifications.

6.1.2.1. The Inherence–Global scale. The Inherence–Global scale consisted of eight explanations for diverse phenomena (see top of Table 4 for full list; $\alpha = .82$). All explanations included explicit mention of inherent features. Participants indicated their agreement with each explanation on a scale from 0 (strongly disagree) to 10 (strongly agree). This measure also included two catch items with obvious answers (one true, one false).

6.1.2.2. The Inherence–Language scale. The Inherence–Language scale consisted of eight explanations for specific word–object pairings (see bottom of Table 4 for full list; $\alpha = .93$). Similar to the Inherence–Global scale, all explanations included explicit mention of inherent features. Participants indicated their agreement with each explanation by using a sliding marker on a scale that ranged from 0 (completely disagree) to 100 (completely agree). This scale also included two attention checks that asked participants to move the sliding marker to one end of the scale. Any participant who missed more than one of the four attention/catch items across the Inherence–Global and Inherence–Language scales was excluded from the final sample ($n = 13$).

6.1.2.3. Cognitive Reflection Test (CRT). We used a version of the CRT (Frederick, 2005) that was superficially different from the original so as to avoid previous exposure among Mechanical Turk workers (Finucane & Gullion, 2010; see also Salomon & Cimpian, 2014). The task consisted of three word problems with salient and intuitive, but incorrect, answers. For example, one problem was as follows: "If it takes 2 nurses 2 min to measure the blood pressure of 2 patients, how long would it take 200 nurses to measure the blood pressure of 200 patients?" The easy, heuristic response to this problem is 200 min, but the correct response is actually 2 min. Responses were coded as either correct (= 1) or incorrect (= 0), and then summed across the three items. Higher scores on the CRT indicate more analytic (and less heuristic) reasoning.

6.1.2.4. The Chance scale. To measure participants' appreciation for the role of chance events, we used five items from Levenson's (1981) Chance scale (e.g., "To a great extent, my life is controlled by accidental happenings"). Response options ranged from −3 (strongly disagree) to +3 (strongly agree), with no midpoint. The scores were summed across the five items, and 15 was then added to the grand total so as to arrive at a possible range of 0–30 (with greater scores indicating greater appreciation for the importance of chance).

6.2. Results and discussion

According to our proposal, participants' heuristic tendency to make sense of the world in inherent terms should be apparent in their reasoning about word-object relations as well, which should in turn lead participants to see a special fit between words and their referents. This predicted path (global inherence → inherence about words → nominal fit) was indeed significant in a bootstrapped product-of-coefficients mediation analysis, $ab = .05$ [.02,.10], $SE = .02$, Sobel test $p = .020$ (Hayes, 2013; see Appendix A for the full correlation matrix and Appendix B for the means).[9]

Next, to test whether our proposed model provides a better fit to the data than other possible models of the relationships between these three variables, we switched the dependent variable (nominal fit) and the mediator (inherence about words). According to our proposal, people's inherent explanations of word–object mappings precede (and give rise to) their beliefs about nominal fit, not vice versa. Thus, we predict this alternative model to be less compatible with the data. Indeed, the path tested in this model (global inherence → nominal fit → inherence about words) was not statistically significant, $ab = .05$ [−.03,.14], $SE = .04$, Sobel test $p = .257$. This result provides additional confidence in our hypothesized model.

In a separate set of analyses, we added the CRT and the Chance Scale as covariates to the original mediation model. The predicted path linking global reliance on inherent explanations with endorsement of nominal fit beliefs through reliance on language-specific inherent explanations remained significant, $ab = .04$ [.01,.08], $SE = .02$, Sobel test $p = .045$ (see Fig. 1 for full results). Moreover, switching the mediator and the dependent variable again led to a non-significant indirect path, $ab = .03$ [−.03,.10], $SE = .03$, Sobel test $p = .436$.

In sum, these results provide further evidence for our prediction that adults' reliance on inherent explanations to make sense of the world, and of word–object mappings in particular, may lead to intuitions that words are a good fit for their referents.

[8] Two participants did not provide demographic information.

[9] Surprisingly, the zero-order correlation between the Inherence–Global scale and the nominal fit scale did not reach significance, $r(126) = .11$, $p = .227$. Further inspection of the data revealed that the relationship between these variables was not linear. Rather, this relationship had a significant (and negative) quadratic component, $b = -.03$ [−.06, −.001], $SE = .02$, $p = .040$, in addition to a significant (and positive) linear component, $b = .46$ [.10,.83], $SE = .19$, $p = .014$. Specifically, the two variables showed a robust positive linear relationship over most of the Inherence–Global scale, a relationship that flattened off at the high end of this scale (hence the negative quadratic component). In sum, the non-significant correlation coefficient masks a much stronger positive relationship between Inherence–Global and nominal fit scores over most values of the Inherence–Global scale.

Table 4
The Inherence–Global and Inherence–Language scales.

The Inherence–Global Scale
(1) There is some feature of orange juice (maybe something about how it tastes or something else) that explains why we drink orange juice at breakfast.
(2) There is some feature of the color red (maybe something about how it looks or something else) that explains why red in a traffic light means "stop."
(3) Girls generally wear pink because of something about the color pink—for example, it looks delicate and flower-like.
(4) Engagement rings typically have diamonds because of something about diamonds—for example, it might be something about how rare they are.
(5) The reason we don't keep chipmunks as pets has to do with the way chipmunks act, or maybe something else about them.
(6) The reason wedding dresses are typically white has to do with the way white looks, or maybe something else about it.
(7) There is some feature of funerals that explains why we associate the color black with them.
(8) There is some feature of mint that explains why we use it to flavor toothpaste.

The Inherence–Language Scale
(1) We use the word "frog" when talking about the amphibian because of something about the word—perhaps something about how it sounds or looks in print.
(2) We call clocks "clocks" because of something about the object—perhaps something about how it works or looks.
(3) The fact that we call giraffes "giraffes" can be explained by some feature of the animal—maybe something about how it looks or something else.
(4) The fact that we use the word "pizza" to talk about the food can be explained by some feature of the word—maybe something about how it's pronounced or something else.
(5) There is some feature of the word "cat" (maybe something about how it sounds or something else) that explains why it is used to talk about cats.
(6) There is some feature of ovens (maybe something about how they work or something else) that explains why the word "oven" is used to talk about them.
(7) The reason we call horses "horses" has to do with something about the animal—it could be something about how it looks or something else about it.
(8) The reason we use the word "milk" when talking about the white liquid has to do with something about the word—it could be something about how it's pronounced or something else about it.

Note. The Inherence–Global Scale also included the following two catch items: "There is something about your favorite sports team that explains why coffee keeps us awake" (false) and "The brightness of the day is usually due to the sun's light, regardless of the season" (true). The Inherence–Language Scale also included two attention checks that directed subjects to slide the response bar to either end of the scale.

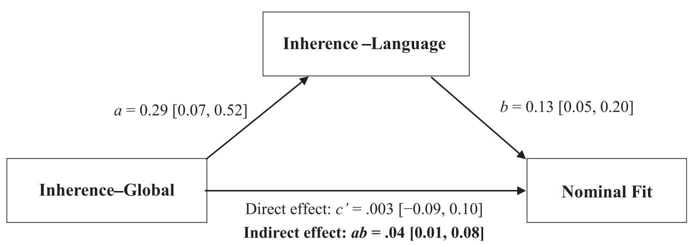

Fig. 1. Mediation model illustrating the indirect path (*ab*) from participants' global inherent reasoning to their nominal fit beliefs via their inherent reasoning about the relation between words and objects. This model included the CRT and the Chance Scale as covariates. The results were estimated with a bootstrapped product-of-coefficients mediation analysis performed with the PROCESS macro (Hayes, 2013) in SPSS 22.

7. Study 6

Thus far, we have found that both children's and adults' belief in a fit between words and their referents is related to their inherence-based reasoning, even when controlling for a variety of alternative factors. In this final study, we tested the causal direction of this relationship (our third prediction): Would manipulating participants' tendency to explain inherently lead to subsequent changes in their endorsement of beliefs about the inherent suitability of words?

7.1. Methods

7.1.1. Participants

Participants were recruited from Amazon's Mechanical Turk and an undergraduate subject pool ($N = 500$; $M_{age} = 35.6$ years; 61% female). All participants completed the study online. An additional 61 participants were tested but excluded from the sample for the following reasons: (1) because they indicated they had not paid attention during the study ($n = 5$), (2) because they guessed the purpose of the study when asked at the end of the session ($n = 17$), or (3) because they failed a comprehension check ($n = 39$) (see below for details).

7.1.2. Procedure and materials

Participants were randomly assigned to one of two conditions that differed in whether they *undermined* or *reinforced* participants' tendency to explain via the inherence heuristic (the Anti-Inherence and Pro-Inherence conditions, respectively). After the manipulation, participants completed a distractor task (which helped disguise the manipulation), followed by a measure of nominal fit and a brief manipulation check.

7.1.2.1. Manipulation. Participants read an article as part of a task on "reading comprehension and memory." In both conditions, the article was titled, "Ever Wonder, 'Why Do We Do It That Way?'" and focused on the example of why recycling bins are blue. In the Anti-Inherence condition, the article explained that the color blue was a "historical accident," having been chosen for no particular reason by the founders of the first recycling program in southern Ontario. The article went on to provide more examples of extrinsic forces that shape the way we do things (e.g., marketing campaigns, influential people). This information was designed to undermine participants' typical explanatory intuitions, which focus on the inherent natures of the things explained rather than extrinsic factors. The article in the Pro-Inherence condition was similar in many respects to that in the Anti-Inherence condition (e.g., length, layout, and examples), except that it claimed blue was chosen because of its visibility and its ability to endure damage from the sun (inherent properties). The article then went on to provide more examples illustrating how the way we do things is in accord with the inherent natures of those things, and is thus optimal (e.g., scientists conduct experiments to determine how to do something optimally). This information was designed to reinforce participants' typical, inherence-based explanatory intuitions.

After reading one of these articles, participants in both conditions completed a series of reading comprehension and memory questions, in keeping with what they had been led to believe was the purpose of the task. In addition to camouflaging the manipulation, these questions allowed us to test whether participants read and understood the information in the manipulation articles. In particular, one of the comprehension questions asked participants to choose which of four statements best summarized the main argument of the article. The correct answer should have been obvious to anyone who read the passage. Thus, this question served as an attention check as much as a comprehension check. Participants who answered this question incorrectly were excluded from subsequent analyses ($n = 39$, as mentioned above).

7.1.2.2. Distractor. Following the manipulation, participants completed a three-minute distractor task consisting of four spatial puzzles.

7.1.2.3. Nominal fit. We used the measure of nominal fit beliefs from Studies 3–5.

7.1.2.4. Manipulation check. Finally, we asked participants to rate their agreement with four items designed to check whether our manipulation was effective in influencing their explanatory tendencies (e.g., "A lot of things that are true today are the way they are because of historical accidents that could have been otherwise" [reverse-coded]). These items were always presented last, just before the demographic questions. Participants marked their answers on a 1 (disagree strongly) to 9 (agree strongly) scale.

7.2. Results and discussion

The manipulation check revealed the expected condition difference, with the Pro-Inherence participants showing a stronger preference for inherence-based reasoning than the Anti-Inherence participants (*M*s = 5.09 and 4.22, respectively; both *SD*s = 1.19), Mann–Whitney $Z = 8.15$, $p < .001$. The key question, however, was whether this manipulation would affect participants' beliefs about the word–object link. As predicted, participants in the Pro-Inherence condition showed stronger intuitions about nominal fit ($M = 2.21$, $SD = 0.86$) than participants in the Anti-Inherence condition ($M = 2.08$, $SD = 0.94$), Mann–Whitney $Z = 2.08$, $p = .038$. In further support of our claim, the effect of the Pro- vs. Anti-Inherence manipulation on nominal fit beliefs was mediated by participants' inherence-based reasoning (as measured by the manipulation check), $ab = .12$ [.06,.19], $SE = .03$, Sobel test $p < .001$ (see Fig. 2 for the full mediation model).

Thus, experimentally manipulating participants' reliance on the inherence heuristic had a downstream effect on their tendency to see words as fitting with their referents. These findings support our proposal that this explanatory process gives rise to intuitions about the non-arbitrary nature of words.

8. General discussion

8.1. Theoretical contributions

The present paper makes two contributions. First, it provides evidence for the psychological reality of the belief that words fit, or are somehow suitable for, their referents. In our studies, nominal fit beliefs were present not only in children's reasoning but were also articulated quite explicitly by many literate American adults (e.g., "The name sounds fitting for what it's meant to do"; see Table 2 for additional examples). The second contribution of this work is that it proposes and tests a potential mechanism underlying these beliefs about nominal fit. We hypothesized that these beliefs are a product of how people make intuitive sense of the world more generally. Recent arguments and evidence suggest that many everyday, in-the-moment explanations are generated using a heuristic process that leads people to routinely appeal to inherent facts, which are highly accessible in memory (Cimpian, 2015; Cimpian & Salomon, 2014a, 2014b; Cimpian & Steinberg, 2014; Salomon & Cimpian, 2014). Given that this process is invoked to explain a wide range of observations, it is reasonable to suppose that it would also shape people's understanding of why objects have the names they do. Due to this heuristic, people might assume that word–referent pairings are explained by inherent aspects of the words or referents themselves rather than by social conventions established in the distant historical past. For example, as one of our adult participants suggested, perhaps a zebra's stripes are part of the reason for the name *zebra*, which suggests that this name is fitting. The six studies reported here support the claim that such nominal fit beliefs stem from the broader tendency to explain heuristically. It is also worth noting that the results of these studies converged on the same conclusion despite considerable variation in the designs they employed (correlational vs. experimental), in the characteristics of their participants (4- to 7-year-olds vs. undergraduates vs. Mechanical Turk workers), and in the questions they used to assess participants' nominal fit beliefs and their reliance on the inherence heuristic. In summary, these results highlight the promise of our proposal that use of the inherence heuristic is at the root of beliefs about the fit between objects and their names.

8.2. Why do beliefs about nominal fit persist into adulthood?

Our results suggested that even adults show traces of a belief that words are suitable for their referents. Why would this be? Surely our (literate American) adult participants would have had plenty of opportunities to realize that language is arbitrary. In today's world, for example, it is nearly impossible to avoid exposure to different languages and thus to different ways of referring to the same objects; many of our subjects even *spoke* more than one language. Why were such experiences not sufficient to dispel any doubts about the arbitrariness of language?[10] We argue that, in and of themselves, linguistic differences of this sort do not *necessarily* undermine the idea of nominal fit. It is not logically inconsistent to believe that names fit their referents while simultaneously acknowledging that different languages use different words for the same thing. The fact that, say, *dog* and *perro* refer to the same animal does not preclude the possibility of explaining both inherently: Perhaps the two words are rooted in, or inspired by, two different aspects of the animal and are thus both a good match. Words can fit an object in many respects. More generally, it is by no means obvious that the only way to make sense of the existence of multiple words for the same thing is to assume that words are largely arbitrary. Arriving at this conclusion might actually require more systematic effort than is typically expended in the course of ordinary cognitive activity.

A related reason for the persistence of nominal fit beliefs might be that the evidence that could potentially weaken such beliefs is often not the most accessible when we're looking for a quick, in-the-moment answer. Although many people of course realize that, say, a bowl is called by very different names in other languages, this fact may not be the first thing that comes to mind when thinking about why a bowl is called a *bowl*. Rather, retrieval may be dominated by inherent facts about the entities in the

[10] Exposure to different languages may be informative up to a point: In Study 1, children with such exposure showed greater understanding of the arbitrariness of words.

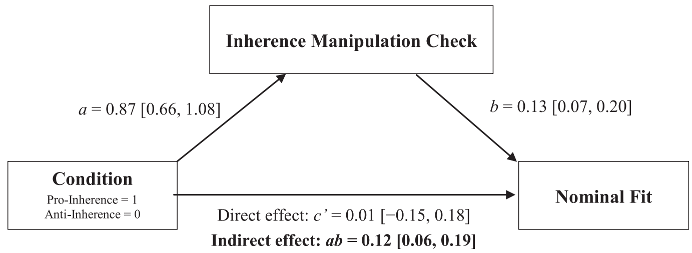

Fig. 2. Mediation model illustrating the indirect path (*ab*) from the Pro- vs. Anti-Inherence manipulation to participants' nominal fit beliefs via the inherence manipulation check. We used a bootstrapped product-of-coefficients mediation analysis performed with the PROCESS macro (Hayes, 2013) in SPSS 22.

explanandum (the object and the word), which then gives rise to an inherence bias in the heuristic explanations generated. This is, we would argue, analogous to how many people are aware of counterexamples to familiar non-linguistic regularities (e.g., engagement rings without diamonds) and still often fail to factor this less-accessible evidence into their explanations (Cimpian & Salomon, 2014a, 2014b; Salomon & Cimpian, 2014). In both cases, the explananda are typically understood as being rooted in inherent facts and thus as being natural and how things should be (e.g., Hussak & Cimpian, in press; Tworek & Cimpian, 2015).

8.3. Nominal fit intuitions: shallow or sophisticated?

So far, we have assumed that nominal fit beliefs are the product of shallow, heuristic processes. One might argue, however, that our participants could have also endorsed these beliefs for sophisticated, well-thought-out reasons. For example, if a participant assumes that (1) animal names in English are derived from their scientific names in Latin, and (2) scientific names function as descriptions of sorts (rather than being entirely arbitrary), perhaps it is reasonable to also assume that current English names are, in this roundabout way, not entirely arbitrary. Similarly, perhaps participants gave nominal fit responses because they extrapolated from the—occasionally non-arbitrary—ways that new words are introduced into English usage. For example, the photographs that people take of themselves are now called *selfies* (the word of the year in 2013, according to the Oxford Dictionaries). Participants may have reasoned by analogy that, just as neologisms like *selfie* or *podcast* seem to provide meaningful descriptions of their referents, established words such as *zebra* or *candle* might likewise provide a good fit for their referents.

The view that participants' nominal fit responses stemmed from sophisticated chains of inferences such as those illustrated above is contradicted by at least two aspects of our data. First, endorsement of nominal fit beliefs in our studies was positively correlated with endorsement of explanations that are heuristic rather than the result of careful thought. It seems unlikely that the same participants would effortfully puzzle their way through one set of questions (i.e., the nominal fit questions) and rely on effort-saving heuristics for another (i.e., the inherence heuristic questions). Second, the pattern of relationships between endorsement of nominal fit intuitions and other variables measured in our studies is exactly the opposite of what would be expected under this alternative. For instance, endorsement of nominal fit was negatively correlated with children's age (Study 1), with adults' fluid intelligence (Study 3), with their counterfactual reasoning ability (Study 4), and with the degree to which they reasoned analytically (Study 5) (see Appendix A). These results suggest that the source of intuitions about nominal fit is less examined and rational than proposed by this alternative hypothesis and more consistent with our interpretation of participants' responses.

8.4. Future directions

On a final note, we hope that one of the lasting contributions of the present work will be to spark new research on people's reasoning about the arbitrariness of language. There is much important work left to be done here. For instance, one potential avenue for future work is to investigate the relationship between the present findings and other lines of research that similarly suggest people underestimate how arbitrary language is. To illustrate, people also tend to assume that (1) idioms such as "spill the beans" or "take the bull by the horns" connect quite transparently, rather than arbitrarily, with their meanings (e.g., Keysar & Bly, 1995) and that (2) the grammatical gender of a noun (in languages that employ this syntactic device) provides a match to the characteristics of its referent (e.g., Boroditsky, Schmidt, & Phillips, 2003). Are the similarities between our data and these other studies coincidental, or are they perhaps due to an underlying similarity in mechanism? And, if the latter alternative is correct, is the common mechanism explanation-based?

9. Conclusion

To conclude, our studies identify a surprisingly robust belief that words fit their referents. Additionally, they provide evidence that this belief is due to use of an inherence heuristic when generating explanations. This work adds an important piece to our understanding of people's basic conceptions about language, and it illustrates the extent to which heuristic explanations underlie our fundamental theories about how the world works.

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Appendix A

Table A1
Correlation matrices of the measures in Studies 1–5.

Study 1	Nominal Fit	Inherence Heuristic	Age	Multilang. Exposure	
Nominal Fit	–				
Inherence Heuristic	.53***	–			
Age	−.43***	−.17	–		
Multilanguage Exposure	−.09	.12	−.11	–	
Study 2	**Nominal Fit**	**Inherence Heuristic**	**Need for Closure**	**Need for Cognition**	
Nominal Fit	–				
Inherence Heuristic	.31***	–			
Need for Closure	.13	.28**	–		
Need for Cognition	−.01	−.28**	−.16	–	
Study 3	**Nominal Fit**	**Inherence Heuristic**	**Raven's SPM**	**Creative Personality**	
Nominal Fit	–				
Inherence Heuristic	.33***	–			
Raven's SPM	−.30**	−.28**	–		
Creative Personality	−.06	−.03	.15	–	
Study 4	**Nominal Fit**	**Inherence Heuristic**	**Counterfactual Thinking**	**Multilingualism**	
Nominal Fit	–				
Inherence Heuristic	.34***	–			
Counterfactual Thinking	−.25**	−.17	–		
Multilingualism	−.06	−.25**	.04	–	
Study 5	**Nominal Fit**	**Inherence–Language**	**Inherence–Global**	**CRT**	**Chance Scale**
Nominal Fit	–				
Inherence–Language	.36***	–			
Inherence–Global	.11	.25**	–		
CRT	−.29***	−.28**	−.13	–	
Chance Scale	.14	−.01	−.01	−.07	–

** $p < .01$.
*** $p < .001$.

Appendix B

Table B1
Means of the measures in Studies 1–5.

Measure	Study 1 (children)	Study 2 (adults)	Study 3 (adults)	Study 4 (adults)	Study 5 (adults)
Nominal Fit (possible range [children] = 0–1) (possible range [adults] = 1–7)	0.55 (0.42)	2.14 (0.85)	2.09 (0.95)	2.41 (1.12)	2.31 (1.06)
Inherence Heuristic (possible range [adults] = 1–9)	0.00[a] (0.79)	5.89 (1.10)	5.85 (1.11)	5.95 (1.28)	–
Age (range = 4.18–7.96 years)	5.89 (1.15)	–	–	–	–
Multilanguage Exposure (range = 0–2)	0.19 (0.43)	–	–	–	–
Need for Closure (possible range = 1–9)	–	5.33 (0.72)	–	–	–
Need for Cognition (possible range = 1–9)	–	5.79 (1.25)	–	–	–
Raven's SPM (possible range = 0–12)	–	–	4.47 (2.45)	–	–
Creative Personality (possible range = −12 to 18)	–	–	4.97 (3.99)	–	–
Counterfactual Thinking (possible range = 1–9)	–	–	–	5.33 (2.28)	–
Multilingualism (range = 0–17)	–	–	–	2.07 (2.70)	–
Inherence–Language (possible range = 0–100)	–	–	–	–	45.47 (24.95)
Inherence–Global (possible range = 0–10)	–	–	–	–	6.76 (1.83)
CRT (possible range = 0–3)	–	–	–	–	1.66 (1.13)
Chance Scale (possible range = 0–30)	–	–	–	–	13.15 (5.97)

[a] Children's scores were standardized (hence the zero average).

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