Separating kindhood from naturalness: Kinds are diverse in causal structure

Alexander Noyes[1] and Yarrow Dunham[2]

[1]New York University, [2]Yale University

Corresponding author: Alexander Noyes

NoyesAlexanderJ@gmail.com

New York University

Department of Psychology

6 Washington Pl

New York, NY 10003

Abstract

We used exploratory factor analysis (Studies 1, 2, 4) and experimental manipulations (Study 3) to examine the relationships between beliefs traditionally understood as essentialist. We uncovered two clusters of beliefs: The first included a belief in inductive potential, homogeneity, and informativity ("kindhood"); the second included a belief in intrinsic causes, mind-independent category boundaries, and immutable category membership ("naturalness"). Kindhood varied in three 'tiers': highest were natural and human-made object categories (e.g., *tiger*, *chair*), followed by social categories (e.g., *lawyer*, *women*), followed by arbitrary categories (e.g., *things weighing more than a bowling ball*). Naturalness varied between natural objects (e.g., *tiger*, *scorpion*) and institutional roles (e.g., *lawyer*, *President*); human-made objects and social categories were spread between these two end points. Participants drew inferences about novel categories in a within-cluster fashion: For example, if they learned a category was informative, they would usually infer it had inductive potential but not consistently infer it had intrinsic causes. In sum, these studies cast doubt on the usefulness of referring to these beliefs as 'essentialist' and reveal the inadequacies of theoretical or methodological practices that treat them as reflecting a single latent construct.

Tiger, *gold*, *senator*, *chair*, *people standing at a bus stop right now*, and *Republican* are a few of the infinite possible categories the human mind can represent. People's beliefs about these categories differ in fundamental ways: For example, people represent *tiger* as mind-independent and *senator* as mind-dependent, such that the former's existence is independent of human intentions and the latter is constituted by them (Gelman, 2003; Rhodes & Gelman, 2009; Noyes, Keil, & Dunham, 2020). According to the literature on psychological essentialism, mind-independence is one of many beliefs that reveal a belief in essences, i.e., a belief that category membership and category-linked properties reflect an intrinsic cause (Gelman, 2003; Medin & Ortony, 1989; Rhodes & Mandalaywala, 2017). According to this framework, a belief in essence is also revealed by believing the category is discovered (rather than invented), immutable (rather than flexible), stable (rather than transient), absolute in its boundaries (rather than graded), and high in inductive potential (rather than low).

A common method for measuring essentialism is triangulation: Researchers use a variety of loosely correlated measures, each providing a noisy, imperfect test of the intended latent construct. For example, one item might measure inductive potential, another mind-independence, and so on. The rationale for this approach is that people have vague, incomplete causal theories; that is, people represent most kinds via a placeholder for some unknown or unspecified essence (Gelman, 2003; Medin & Ortony, 1989). Because of this vagueness, it is difficult to directly measure the belief that a category has an essence so we instead measure its indicators or "symptoms". Indeed, psychological essentialism appears to be a syndrome rather than a well-defined psychological process, intuitive theory, or cognitive disposition (Rhodes & Mandalaywala, 2017).

To establish psychological essentialism as a well-defined phenomenon, we need to understand the relationship between its purported symptoms. Such an investigation will reveal whether the complex of beliefs understood as "psychological essentialism" are in fact best understood as outcomes of a single latent construct or outcomes of distinct constructs. Conflating these two possibilities would hinder progress in describing and eventually explaining the phenomenon because it might motivate empirical approaches that obfuscate it. And, even if there is one latent variable among the beliefs currently associated with essentialism, it is worth establishing which beliefs are reliable indicators of essentialism in order to prune away beliefs that are not reliable indicators (as those would add noise to existing measures).

The first study to take these concerns seriously used exploratory factor analysis to examine beliefs that had been associated with psychological essentialism in the context of social categories (Haslam, Rothschild, & Ernst, 2000). This study uncovered two latent factors: The degree to which a category was understood as natural, and the degree to which a category was understood as coherent (what they called *entitativity* but which, given our focus on multiple category domains, we refer to as *kindhood*). A later study replicated this two-factor structure in three cultural contexts: USA, China, and Northern Ireland (Coley et al., 2019). Other work not directly assessing the two-factor structure also finds signs that these two constructs are distinct: For example, Hussak and Cimpian (2019) found different developmental progressions of inferences that can be mapped onto these two factors, with children coming to understood nationality as less natural but as more cohesive over time. Noyes and Keil (2019; 2020) found that generic language *per se* increased the perceived kindhood of social categories, whereas the property content of generics (i.e., biological versus cultural properties) affected perceived naturalness.

In response to studies indicating that beliefs associated with psychological essentialism dissociate, researchers have generally accepted that psychological essentialism is probably not one thing (Gelman, 2003; Rhodes & Mandalaywala, 2017; Prentice & Miller, 2007). Nevertheless, the partial consensus is that 'psychological essentialism' can be the target of empirical investigation, measured through composite scales, and framed as a unitary phenomenon in descriptions of findings, such that it makes sense to make claims like "psychological essentialism predicts intergroup bias" (the title of Chen & Ratliff, 2018). The tacit assumption appears to be that ostensible components of psychological essentialism converge for ideal (e.g., tigers, gold) and anti-ideal (e.g., white things) cases. When people reason about plants, animals, and minerals, they express the clearly identifiable complex of beliefs known as psychological essentialism; when people reason about contrived categories like 'white things' they show none of these beliefs. In other words, psychological essentialism coheres as a "natural kind syndrome" with a family-resemblance structure; exemplars vary in how well they approximate the ideal natural kind but there are clear instances (e.g., tiger) and non-instances (e.g., white things) of essentialized kinds. Social categories, which are extremely diverse and culturally variable, elicit mixed intuitions, such that beliefs associated with psychological essentialism are dissociable and may be triggered by different environmental inputs (Rhodes & Mandalaywala, 2017). Nevertheless, each of these beliefs disposes one to view a social category as natural kind-like, conferring a common theoretical and practical significance to these beliefs (Rothbart & Taylor, 1992).

Although broadly consistent with existing data, other quite different interpretations are also possible. Importantly, most existing data concerns social categories (e.g., Haslam et al., 2000; Hussak & Cimpian, 2019; Noyes & Keil, 2019; 2020). But, as mentioned above, the

justification for current conceptions of psychological essentialism comes from a broader portrait of categories, including natural categories (e.g., tigers, gold), familiar artifact categories (e.g., chairs, tables), and contrived categories (e.g., white things). The ultimate utility of understanding these beliefs as components of psychological essentialism depends on the degree to which these beliefs converge and diverge in the context of all these categories. In the next section, we outline two possible models of ordinary categories that are consistent with Haslam et al., (2000)'s findings and show how evidence from social categories alone is insufficient to adjudicate between them. Instead, these models need to be adjudicated by evidence from several major category domains.

In one model (Figure 1, Left panel), people hold essentialist beliefs about natural kinds but not artifacts (Malt, 1990; Gelman, 2003). Psychological essentialism varies between these two poles, with essentialist beliefs uniformly present for natural kinds and uniformly absent for artifacts (or at least, for entirely artificial categories like *white things*). Social categories are intermediate between natural kinds and artifacts, with some social categories represented more similarly to natural kinds and others more similarly to artifacts (Rothbart & Taylor, 1992). This intermediacy explains why essentialist beliefs cohere less well for social categories than for other domains (Gelman, 2003). Indeed, people possess multiple, overlapping intuitions about the origins of group differences (Martin & Parker, 1995). Nevertheless, plotting this model onto the two-dimensional space observed by Haslam et al. (2000), the critical prediction is that major category domains should vary along a reasonably tight diagonal axis, such that essentialist beliefs could be approximated by a single dimension, and natural kinds and artifacts could be adequately described as occupying different positions on that single dimension. This pattern of

variation would provide the rationale for a 'natural kind syndrome' model of psychological essentialism.

In a second model (Figure 1, Right panel), beliefs associated with psychological essentialism are not adequately described as a single theoretical construct, such that categories pervade the entire two-dimensional space. With respect to the 'kindhood' dimension, there are at least two major types: natural and social. Consequently, a single dimension would fail to reasonably approximate people's beliefs about ordinary categories, and natural kinds and artifacts would be two poles of variation in one axis (naturalness) but not another (kindhood). Moreover, there would be no rationale for a 'natural kind syndrome' model of psychological essentialism because categories high in kindhood would resemble social kinds just as well as natural kinds (and categories high in naturalness would resemble natural non-kinds just as well as natural kinds).

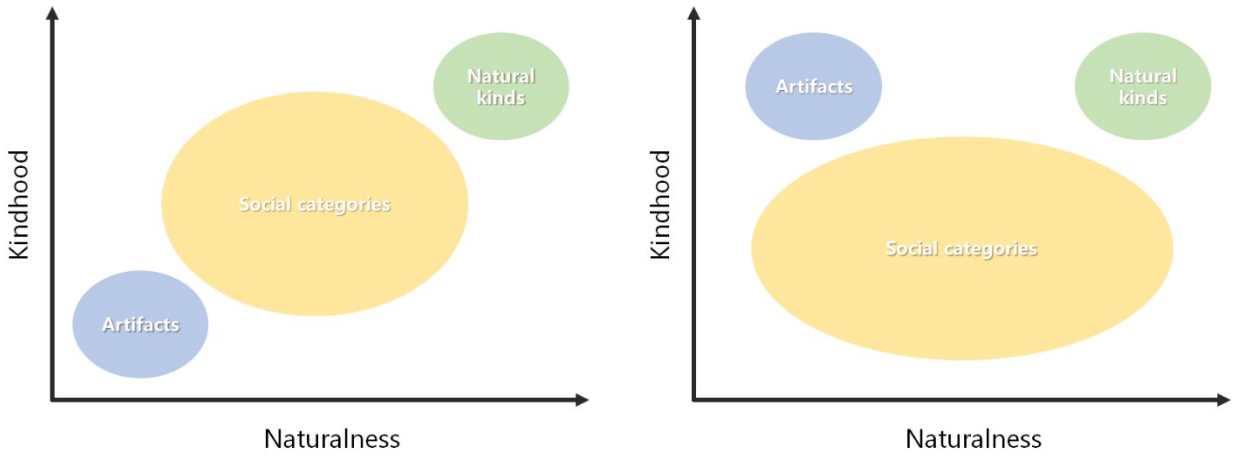

Figure 1. Two models of ordinary category domains consistent with results from Haslam et al., (2000). In the Left panel, major category domains vary along a diagonal axis, with natural kinds and artifacts two poles of that axis. In the Right panel, major category domains vary freely in the two-dimensional space; artifacts and natural kinds are both kinds and vary in naturalness.

Therefore, the theoretical implications of prior findings cannot be fully understood without examining the structure of these beliefs with respect to categories from several major

category domains. In Studies 1, 2, and 4 we conducted exploratory factor analysis with diverse categories, including natural categories (animals, plants, minerals), artifacts (tools, vehicles, furniture), and social categories ranging from institutional roles (e.g., senator) to those with real (e.g., Down syndrome) or assumed (e.g., race) genetic causes. In Study 4, we included contrived categories (e.g., "people sitting in a chair right now"), which helps to clarify whether the kindhood dimension is really diagnosing kinds at all, and whether all essentialist beliefs are absent for non-kinds or whether non-kinds vary in naturalness.

A related question is the causal relationship between beliefs about categories: When a person comes to understood a category as high in one attribute (e.g., inductive potential), how does that inform their assumptions about other attributes (e.g., immutability)? Prior research suggests that beliefs related to kindhood induce beliefs related to naturalness (Cimpian & Markman, 2011; Gelman, Ware, & Kleinberg, 2010; Rhodes, Leslie, & Tworek, 2012). Specifically, this research finds that generic language conveys that a category is informative and its members homogeneous (Foster-Hanson, Leslie, & Rhodes, 2019), which in turn conveys that a category is natural (Rhodes et al., 2012). However, recent research qualifies the relationship, suggesting that generic claims only induce naturalness beliefs when the content of those claims independently motivates that conclusion (e.g., "Asian people are lactose intolerant" can convey to a listener that the category *Asian* is a natural kind because of people's assumptions about the likely cause of lactose intolerance, not because of the mere use of a generic; Noyes & Keil, 2019; 2020). Thus, there may be no principled relationship between kindhood and naturalness; people may be flexible in the causal and constitutive structures they infer as generating kinds, depending on their assumptions about the properties that are predicated of the kind.

With the exception of research on generic language, the causal relationships between different attributes of category structure remain under-examined. To better understand these relationships, we undertook Study 3 to examine how diverse beliefs attributed to psychological essentialism affect one other, allowing us to examine the entire network of causal relationships between beliefs often subsumed under the essentialism umbrella. This allows a considerably more complete description of how these beliefs relate, and in particular allows us to see whether they form a single, dense cluster (such that any one of these beliefs conspires one towards a 'natural kind'-construal) or whether naturalness and kindhood beliefs form richly connected local clusters with sparser connections across those two dimensions.

Together, these 4 studies will provide additional insight into the structure of presumed essentialist beliefs. Specifically, we aim to distinguish between a model where beliefs associated with psychological essentialism cohere as a 'natural kind syndrome,' and a model where there is no rationale for considering naturalness and kindhood as components of a single psychological phenomenon.

Study 1

We used exploratory factor analysis to investigate how different beliefs associated with psychological essentialism relate to each other. We examined these beliefs in the context of major category domains, including natural kinds (e.g., animal, plant, mineral), artifacts (e.g., furniture, tools, appliances), and social categories (e.g., occupations, religion, race, gender). We could then use the factor structure, and the relationship between major category domains within that structure, to begin evaluating competing models of category representation.

Study 1

2.1 Method

2.1.1. Participants

We recruited 450 participants. 448 completed the full survey and were included in analysis. The demographics of the sample, provided by Turk Prime, were: 59% male and 41% female; 69% White, 15% Black, 7% Asian, 6% Hispanic/Latino, and 2% other. 47% of participants were born in the 1980s, 30% in the 1990s, 10% in the 1970s, 7% in the 1960s, 5% in the 1950s. The study methods and sample were approved by Yale University's Institutional Review Board, HSC protocol 1305012100: "Development of Social Category Knowledge."

1.1.2. Materials and Procedure.

2.1.2.1. Category Selection. We examined people's beliefs about natural, social, and artifact categories (Table 1). We selected diverse categories within each of these domains. We examined animals, plants, and minerals. Among artifacts, we selected for variation in complexity since Keil (1989) suggested there were importance differences between the representation of complex artifacts (e.g., cars and computers) and simple ones (hammers and chairs). Among social categories we examined diverse types that prior work has found important variation among (Haslam et al., 2000). We selected categories that were at or near the basic-level (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), while also trying to keep the categories alignable across different domains and sub-domains. For example, "tree" might be basic-level for many participants (Medin, Lynch, Coley, & Atran, 1997), but we decided "oak tree" was more analogous to the average level of the other categories.

Table 1.
Categories used in Study 1 and Study 2 (in parentheses).

Natural Terms	***Social Categories***	***Artifact Categories***
1. Tiger (Lion)	16. Black (White)	31. Dishwasher (Refrigerator)
2. Dog (Cat)	17. Women (men)	32. Hammer (Screwdriver)
3. Robin (Crow)	18. Lawyer (doctor)	33. Chair (Table)
4. Salamander (Gecko)	19. Scientist (artist)	34. Car (Boat)
5. Spider (Scorpion)	20. Christian (Jew)	35. Spoon (fork)
6. Rose (Lily)	21. Gay (Straight)	36. Cup (Bowl)
7. Cucumber (Zucchini)	22. Liberal (Conservative)	37. Backpack (suitcase)

8. Oak trees / (Elm trees)	23. Schizophrenic (Depressive)	38. Football (Basketball)
9. Poison ivy (Stinging nettles)	24. Asian (Hispanic)	39. Paperclip (Binder clip)
10. Moss (ferns)	25. Patriots (Dallas Cowboys)	40. Book (pamphlet)
11. Ruby (Sapphire)	26. American (Canadian)	41. Pencil (pen)
12. Gold (Silver)	27. Autistic (Down syndrome)	42. Window (Door)
13. Aluminum (Tin)	28. Deaf (Hearing)	43. Telescope (Microscope)
14. Water (alcohol)	29. Teacher (Student)	44. Television (Computer)
15. Urine (milk)	30. President (Vice-President)	45. Toilet (Sink)

Note. Categories in parentheses were used in Study 2.

2.1.2.2. Category structure judgments. Next, we included measurements of beliefs that prior work has enumerated as, or implied were, components of psychological essentialism (Table 2). In creating the list, we sought authors from diverse theoretical perspectives on psychological essentialism, attempting to balance definitions from developmental (Carey, 1996; Keil, 1989; Gelman, 2003; Rhodes & Mandalaywala, 2017), cognitive (Medin & Ortony, 1989; Ahn, Flanagan, Marsh, Sanislow, 2006; Rips, 2001), and social psychology (Prentice & Miller, 2006; 2007; Haslam et al., 2000; Keller, 2005).

We aired on the side of cleaving dimensions into simpler constituents, and adding measures that might be redundant. For example, we differentiated immutability (an entity can never change) from flexibility (an entity can easily change). We did not want to pre-cluster beliefs that might seem similar or redundant to us but which actually show distinct patterns of correlations. We also considered this desirable because it meant that if a specific item failed to capture variation because of wording issues, modest redundancy prevented that entire feature of category structure from dropping out of our model.

After judgments were collected, they were converted into wording that could accommodate with minimal changes the diverse categories we wanted to investigate. This entailed making each sentence intelligible across the domains. This imposed constraints such that domain-specific features were dropped. For example, biological inheritance, whether present or absent, does not extend to non-living kinds like natural substances and artifacts (that said, see

Study 4 for a domain-general interpretation of inheritance, i.e., that properties from one 'generation' of members can affect the properties of future generations, as might happen when creators of chairs copy the features of already existing chairs). Item wording went through several iterations during a development phase. Research assistants were read the questions for different categories and asked (1) to interpret the intended meaning of the question, and (2) whether the question made sense for the category – independent of whether the question was ultimately true or false. We iterated this process until questions were reliably interpreted correctly, and sounded natural, for the diverse categories.

Table 2.
Components of category structure used in Study 1, using tiger *as our reference category (but the same questions were asked of all categories in Table 1).*

ReIm. There is such a thing as tigers; people do not simply imagine that there are tigers.
-ReLa. We have a word for tigers, but there actually are no such things as tigers.
-ReBe. If two people disagree about whether an animal is a tiger, then it is possible that both of them are right.
ApTr. If someone took a tiger, and made it look like a non-tiger, it would still be a tiger.
-EnvE. Suppose there was an animal that people thought was a tiger. People's beliefs would make the animal become more like a tiger over time.
EnvL. Suppose a tiger was born on an island with a culture very different than our own. It would end up basically the same as the tigers where we live.
Excl. If an animal is a tiger, then it is excluded from similar categories.
Disc. Any given animal is either fully a tiger or not a tiger at all. There is nothing in-between.
StaP. The characteristics of tigers today will be the same characteristics tigers have a thousand years from now.
Info. There is a large set of information I would learn about something just by knowing it is a tiger.
-Hete. Individual tigers have very little in common.
IndP. Someone tells you a fact about an individual tiger. This fact is very likely true of other tigers as well.
UnSt. One can assume there is some real-world (social, historical, biological, chemical, or design) process that makes something a tiger.
ChIn. Tigers have different internal or microscopic properties than non-tigers.
IntC. Tigers have internal or microscopic properties that cause their characteristic appearance and behavior.
Inhe. Underneath superficial similarities and differences, all tigers are basically the same.
-BouD. The boundary between the category tiger and non-tiger is something decided by people.
-BouC. The boundary between the categories tiger and non-tiger is influenced by culture.

-BouO. Suppose in America we think that one animal is a tiger and a second animal is a non-tiger. If another culture thinks they are both tigers, the other culture could also be right.
-InvT. The category tiger was invented by people.
Immu. A tiger can never change into a non-tiger.
-Flex. It is easy for a tiger to become a non-tiger.
ForE. For some properties that tigers have, it makes sense to say: "This animal has that property because it is a tiger".
SciH. A scholar of some kind (physicist, historian, sociologist, biologist, etc.) could write an entire book about the historical origins of tigers in the world.
Nece. There are necessary properties something needs to have to be a tiger. Something cannot be a tiger without these properties, no matter how similar it is to tigers in other ways.
Suff. If something has a certain property, it is a tiger, no matter how different it is from other tigers.

Note. A list of all category structure judgments used in Study 1, with a four-letter code for identification in later tables and figures. A negative sign (-) indicates the judgment is reverse code. **Bold** indicates that the judgment was retained in the factor analysis and used in Study 2 and 3.

2.1.2.3. Factor Analysis Plan. *Data Collection*. We planned to conduct our factor analysis with categories as the unit of analysis. Therefore, we aimed to collect 50 participants per cell (category-judgment pair). Participants were randomly assigned to rate 5 categories per judgment. Participants answered each of the five judgments in randomized order. We then averaged individual responses into 45 category estimates per judgment. *Extraction Method*. We were interested in latent, theoretical structure, so we conducted an exploratory factor analysis using the minimum residual method. *Rotation*. There was no assumption that the different factors were uncorrelated, so we used oblique rotation, which allows for factors to correlate. Below we show that using uncorrelated factors produces a similar two-factor solution. We did not *a priori* prefer promax or oblimin, so we examined each. If they produced different results, we planned to favor whichever produced the simplest structure (i.e., no factors correlated above .70, absence of factors that cannot be easily interpreted, factors retaining at least 3 items each, and where had minimal cross loadings greater than .30). *Number of factors*. We decided to privilege parallel analysis to determine the number of factors, which research suggests is more reliable than other methods like Scree plots or eigenvalues (Hayton, Allen, Scarpello, 2004). *Iterative analysis*.

After the first pass, we planned to re-examine the factor analysis when pruning items that lacked primary loadings above .50, which had cross loadings above .30, or which Cronbach alpha analyses suggested would improve reliability of any factor. *A priori theoretical considerations.* We decided that if our factor analysis produced plausible, competing factor solutions that conformed to the above guidelines about rotations and number of factors, then any factor structure that conformed to an established model in the field (i.e., a single natural kind dimension, or a naturalness and kindhood model) should be favored to novel factor structures.

2.2. Results and Discussion

Parallel analysis suggested a two-factor solution. The 2-factor solution looked highly similar for Oblimin and Promax, so we report the Oblimin solution below (Table 3). A total of 14 items met our retention criteria. 8 components were removed because they lacked any primary loadings greater than 0.6, and 5 components were removed because they loaded onto both factors. Note, removing these items does not bias analyses towards a two-factor structure; rather, the two-factor structure was suggested by extraction methods prior to item removal (parallel analysis). Nor does it bias the correlation between these two factors (see more below). Likewise, the distribution of categories in two-dimensional space is trivially influenced by the inclusion or removal of these items. Retaining beliefs about category structure that are caused by two distinct latent variables simply leads to imprecise measurement of the two latent variables.

Factor 1 captured 28% of the total variance and explained 50% of the common variance. It represented 8 components: similarity across contexts (EnvL), mutually exclusive membership (Excl), discrete boundaries (Disc), informativity (Info), homogeneity (-Hete), inductive potential (IndP), shared structure (Inhe), and capacity to support formal explanations (ForE). Overall, these items suggested a dimension of kindhood; particularly, informativity, homogeneity,

inductive potential, shared structure, and formal explanations all unambiguously signal kindhood and are central to this construct in prior research (e.g., the kind component in Gelman 2003). The other items were less obviously related to kindhood though they were not inconsistent with it. We had expected the belief that category members are similar across contexts to relate to naturalness (EnvL); however, as written, a kind-based interpretation is plausible. For example, even though chairs are cultural artifacts, their properties are constrained by the functional requirements of providing human beings a place to sit, and so despite variation in superficial features, they share conceptually deep ones (e.g., their basic blueprint / configuration and purpose; how humans interact with them). Participants may have focused on these fundamental similarities rather than conceptually peripheral ones. The belief in mutually-exclusive and discrete boundaries (Excl, Disc) was less obviously related to kindhood (though not so obviously related to naturalness either). In this case, the beliefs did show lower loadings (less than .70) and the mutual-exclusivity item proved volatile in Study 2, as it did not load on this dimension in that study. In Haslam et al. (2000), discreteness loaded with naturalness-related items, and mutual-exclusivity with kindhood-related items. Prior work also finds that intuitions about these features of kinds are inconsistent; e.g., Kalish, 1995 vs. Rhodes & Gelman, 2009). Notwithstanding these considerations, 5 / 8 of the dimensions strongly implied kindhood, and this interpretation is strengthened by the picture of how category domains varied by this dimension (see Figure 2): Both natural kinds and artifacts were high in this dimension, suggesting that this dimension did not represent naturalness. One alternative interpretation is that this dimension represented social versus non-social categories (see more below); we address this in Study 4.

Factor 2 captured 28% of the total variance and explained 50% of the common variance, suggesting that the two factors were roughly equal in explanatory power. It had a .39 correlation

with Factor 1. It represented 6 components: unaffected by people's beliefs (-EnvE), internal / microstructural causes (IntC), non-legislated boundaries (-BouD), non-invented boundaries (-IntT), immutability (Immu), inflexibility (-Flex). These beliefs more clearly denote naturalness, such that categories high in this dimension are understood as reflecting natural structure and categories low in this dimension are understood as reflecting social structure. This interpretation is strengthened by the picture of category domains varied by this dimension (see Figure 2): Natural categories (plants, minerals, animals) and social categories with assumed natural causes (e.g., race and gender) were high in this dimension, and artifacts and social roles were low.

Table 3. Factor structure recovered in Study 1.

Component Abbreviations	Factor 1 **Kindhood**	Factor 2 **Naturalness**
-EnvE		**.70**
IntC		**.79**
-BouD		**.88**
-InvT		**.97**
Immu		**.66**
-Flex		**.75**
EnvL	**.85**	
Excl	**.68**	
Disc	**.64**	
Info	**.70**	
-Hete	**.93**	
IndP	**.92**	
Inhe	**1.03**	
ForE	**.83**	

Note. Abbreviations can be found in Table 2. We paraphrased what they meant in Results text above. We removed loadings under .60 and cross-loaded components). The minus sign means the items were reverse coded.

The two-factor space revealed the presence of both socially constituted kinds and naturally constituted non-kinds. For example, *Black people* produced among the largest difference between naturalness and kindhood; it was high in naturalness but low in kindhood, i.e., it was a naturally occurring non-kind. *Hammer* displayed the opposite pattern: it was high in

kindhood but low in naturalness, i.e., it was a social kind. *Oak trees* and *New England Patriots* exemplified natural kinds and social non-kinds, respectively. Importantly, categories occupied all four quadrants of the two-dimensional space (Figure 2).

As noted, there was a moderate correlation between the two factors, both before (r = 0.39) and after (r = .38) removing items. Forcing the two-factor structure to be orthogonal (uncorrelated) produced a highly similar two factor structure: Factor 1 loaded most clearly onto Disc, -Hete, IndP, UnSt, Inhe, ForE. Factor 2 most clearly loaded onto -EnvE, -InvT, -BouD, -Flex.

The .38 correlation is substantially lower than the typical threshold that would warrant collapsing these factors together into a single factor (typically r = .70). The correlation slightly exceeds the weak correlation (0 to 0.30) that is most consistent with a model where kind representations are unrelated to essences (but see Study 4 where the two factors had an even weaker correlation that fell in this threshold). But it deviates even more from the strong relationship (0.7 to 1.0) one would predict based on a model where categories vary on a dimension of 'natural kind-hood' (i.e., psychological essentialism). This is visible in Figure 2, as there is no obviously diagonal axis along which categories vary, as one would have expected if the single natural-kind syndrome model were true (see Figure 1). Therefore, although the correlation is more consistent with our predicted model, the causal relationships (kindhood to naturalness, naturalness to kindhood) will prove important for fully adjudicating the nature of their relationship (see Study 3).

Next, we examined how category domains varied on these two abstract dimensions. We first compared the pre-existing domains on the different factors (using paired t-tests across items), starting with the naturalness factor: Artifacts, M = 3.35, 95% CI: [3.26: 3.44], p = .004, d

= .90, were rated as ontologically social, and natural kinds were rated as ontologically natural, *M* = 4.12, 95% CI: [4.06: 4.19], p < .001, *d* = 5.26. All simple artifacts were to the left of the midpoint of naturalness, whereas complex artifacts like computers were to the right (Keil, 1989). Social categories, *M* = 3.21, *95%:* [2.87: 3.55], *p* = .099, *d* = .47, were not different from the midpoint, but they turned out to be highly variable – see below for further discussion. Social categories and artifacts were not different from each other, *p* = 3.95, *d* = .32, but were both lower than natural kinds, (social categories), *p* < .001, *d* = 2.05, (artifacts) *p* < .001, *d* = 5.42. On the kindhood factor, both natural kinds, *M* = 4.21, 95% CI: [4.14: 4.29], *p* < .001, *d* = 5.38, and artifacts were rated as kind-like, *M* = 4.10, 95% CI: [4.00: 4.20], *d* = 3.29, whereas social categories were rated as not kind-like, *M* = 3.21, 95% CI: [3.11: 3.31], *d* = 1.61. Natural kinds and artifacts were both more kind-like than social categories, (natural kinds), *p* < .001, *d* = 6.38, (artifacts), *p* < .001, *d* = 4.93, and natural kinds were non-significantly more kind-like than artifacts, *p* = .061, *d* = .72. This raises a concern that kindhood dimension is not diagnosing kinds versus non-kinds but diagnosing non-social versus social categories. We address this in Study 4.

All of these comparisons were conducted on our pre-conceived notions about the domains; but does this domain structure emerge if we employ a data-driven approach? To answer this question, we turned to cluster analysis. Average silhouette width, the plot of the within-groups sums of squares by number of clusters, and Ward hierarchical clustering all suggested four clusters. The four clusters were easily identifiable as natural kinds, artifacts, naturalized social categories, and social roles (Figure 2). The only surprising outlier was *Books,* which was placed with naturalized social categories (however, for reasons of conceptual coherence we keep *Books* with artifacts when performing additional analyses). Thus, the cluster analysis suggested that the pre-conceived boundaries were fairly accurate, but that social categories actually

comprise two distinct clusters. Naturalized social categories were rated as natural, $M = 3.83$, 95% CI: [3.66: 4.00], $p < .003$, $d = 1.82$: *Deaf people, Women, Autistic people, Schizophrenic people, gay people Asian people,* and *Black people*. Social roles were rated as highly social, $M = 2.67$, 95% CI: [2.56: 2.77], $p < .001$, $d = 6.71$: *Lawyers, Presidents, New England Patriots, Teachers, Christians, Scientists, Liberals,* and *Americans*. Both naturalized social categories, $M = 3.16$, 95% CI: [2.93: 3.38], $p = .010$, $d = 1.39$, and social roles, $M = 3.18$, 95% CI: [3.18: 3.23], $p < .001$, $d = 2.91$, were seen as below the midpoint on kindhood. We can then compare these two new clusters to artifacts and natural kinds. Naturalized social categories were less natural than natural kinds, $p = .004$, $d = 2.10$, but were more natural than artifacts, $p < .003$, $d = 2.84$, and social roles, $p < .001$, $d = 7.61$. Social roles were less natural than all other domains: (natural kinds), $p < .001$, $d = 12.10$, (artifacts) $p < .001$, $d = 4.57$. On the kindhood dimension, social roles and naturalized social categories were lower than all other domains, $ps < .001$, but were not different from each other, $p = .365$, $d = .53$. Overall, then, every quadrant of the naturalness-kindhood grid had constituents: Natural kinds was exemplified by animals, plants, and minerals, and somewhat by complex artifacts. Natural non-kinds were exemplified by naturalized social categories. Social kinds were exemplified by simple artifacts, and social non-kinds were

exemplified by social roles.

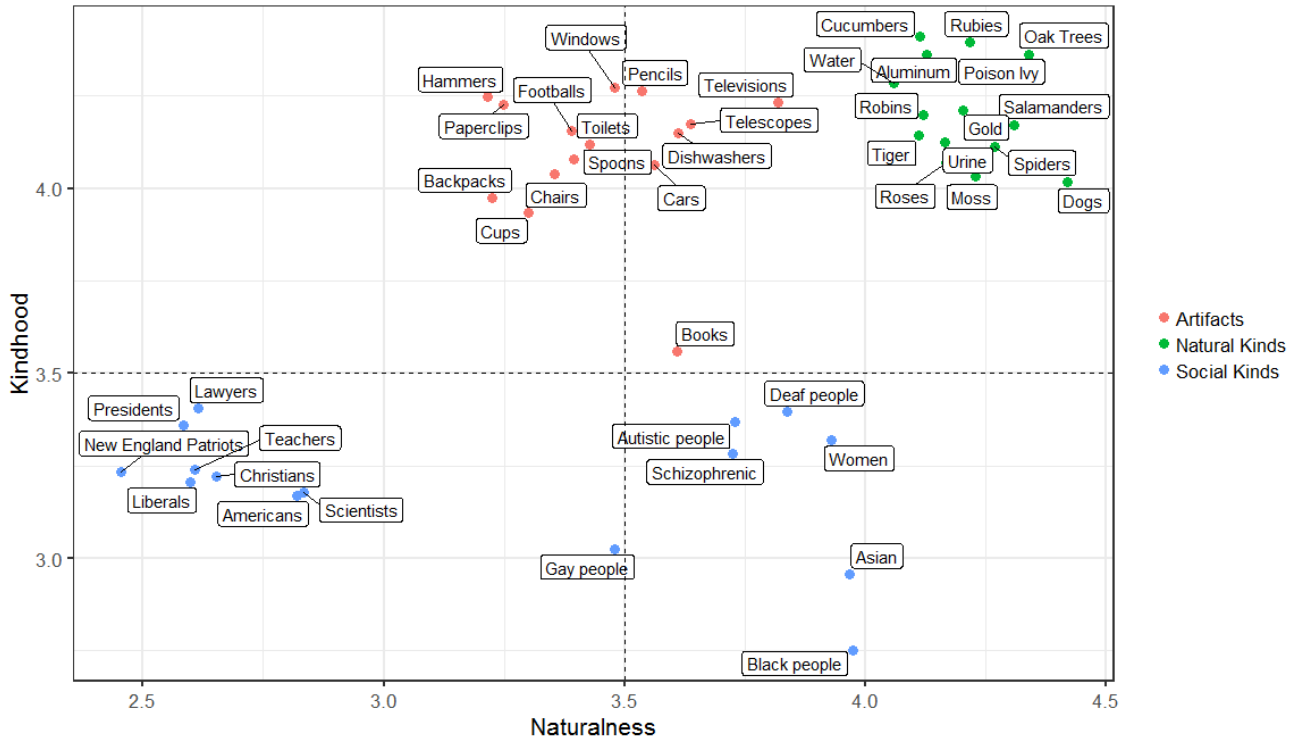

Figure 2. A plot of the categories in the two-factor space, naturalness by kindhood.

We were surprised that social categories were universally below the midpoint on kindhood. We expected there to be kinds among social categories, such as occupational roles (i.e., lawyer) and gender (i.e., woman). These did hover close to the midpoint. Perhaps social categories are represented as intermediate on kindhood rather than represented as genuine non-kinds. Indeed, one can represent social categories either as kinds or as collections of people, whereas people rarely represent animals and artifacts as populations of individuals but rather overwhelmingly represent them as kinds (Ritchie & Knobe, 2020). Social categories also overlap; a single individual could belong to almost all of the social categories we tested at the same time. But people probably represent individual artifacts and animals as belonging only to one category, with alternative categories tending to operate at different taxonomic levels (chihuahua – dog – mammal). Thus, it may be reasonable to expect social categories to be lower in kindhood than animals and artifacts. Still, this pattern raises the concern that our purported 'kindhood' dimension is really tracking the social / non-social distinction. We return to this issue in Study 4, in which we include clear non-kinds: e.g., 'people standing at a bus stop right now' and 'animals whose English name starts with C.' If the dimension represents kindhood, we should see three tiers of variation: natural kinds and artifacts highest and above the midpoint, social categories near the midpoint, and non-kinds below it. We should see non-kinds below the midpoint regardless of their status as social or non-social.

The results of Study 1 are more consistent with a picture of kinds as independent of essences, such that there can be natural and social kinds. More specifically, we observed a clear distinction between a dimension of naturalness and kindhood, and found that categories pervade that entire two-dimensional space. Further, both natural categories and artifacts were represented as high in kindhood. In Study 2, we undertake a replication study to ensure the robustness of this pattern.

2. Study 2

In Study 2 we carried out a pre-registered replication of the exploratory factor analysis: https://osf.io/bgtk7/. We used the same components of category structure from Study 1, but used only those components that were retained to ensure that the factor structure observed above did not depend on items we then removed. We replaced all of the categories with new categories (see Table 1). We then used exploratory factor analysis techniques to measure the robustness of the factor structure.

2.1. Method

3.1.1. Participants

We again recruited 450 participants who were divided among the cells in the same manner as Study 1. Demographics were provided by Turk Prime: (gender) 61% male and 39% female; (race) 69% White, 11% Black, 9% Hispanic/Latino, 9% Asian, 2% other (birth decade) 46% 1980s, 24% 1990s, 20% 1970s, 7% 1960s, 2% 1950s, 1% 1940s.

3.1.2. Procedure and Analysis Plan

We used the 14 components of category structure retained from Study 1 and replaced the categories with a new set listed parenthetically in Table 1. We pre-registered using parallel analysis again. Since we used Oblimin in Study 1, we pre-registered using that rotation. We also pre-registered looking at the same cluster analysis techniques to see whether we would replicate 4 clusters.

Our minimum threshold of complete success is that we find the same basic factor structure. Parallel analysis should suggest 2 factors, and the same questions should be assigned to the same factor (defined here as the strongest factor loading should be on the same factor for each question). Within this minimum threshold, we defined complete success as parallel analysis

favoring 2 extracted factors and 100% of questions loading onto the same factor. We defined partial success as parallel analysis favoring 2 extracted factors and at least 80% of questions loading onto the same factor. Failure to replicate will obtain if the number of factors extracted does not equal 2 or if less than 80% of questions load onto the same factor.

Following Osborne & Fitzpatrick (2012), we will report the factor loadings of each question in Study 2 subtracted from the corresponding loading in Study 1 squared (since positive and negative movement is not important, only magnitude). This metric reveals the volatility of the item: Scores above .04 indicate possible volatility. We considered the replication strong if no items proved volatile. But we considered volatility consistent with a complete or partial replication; we only used the number of volatile items to qualify the replication.

To replicate our cluster analysis, the K-mean clustering and ward hierarchical clustering should return 4 factors. Those clusters should contain mostly the same types of items: natural kinds (e.g., animals, plants, and minerals), naturalized social categories (e.g., race and gender), social roles (e.g., occupations), and standard artifacts (e.g., tool and technology). We will consider the replication a failure if the number of clusters deviates or the 4 clusters contain different kinds of items.

We also report Tucker's coefficient of congruence (Tucker, 1951). The congruence coefficient, ϕ, ranges from -1 to 1 and quantifies the similarity between two vectors of loadings (Davenport Jr., 1990). Following guidelines from Lorenzo-Seva and ten Berge (2006), we will conclude that this metric supports successful replication (i.e., a similar factor structure) if the coefficient is greater than .85.

We also report common CFA measures. Following Kline (2005), we will report: 1) The model chi-square 2) RMSEA 3) CFI 4) SRMR. However, following Barrett (2007), the Chi-

Squared Test exhibits a high false positives rate. Therefore, though a null rest on the Chi-Squared Test will provide strong evidence of similarity, we will not consider a positive result as a decisive failure. Study 2 was an attempted replication of the exploratory factor analysis, and was not intended as confirmatory factor analysis – but we considered this information valuable and as qualifying the nature of the factor structure.

2.2. Results and Discussion

Like Study 1, parallel analysis suggested 2 factors (Table 4.) The primary loadings of every component were consistent with Study 1, and thus consistent with our conditions of complete replication. Only one item (mutually exclusive category boundaries; Excl) was volatile, and thus our complete replication was qualified only marginally. Likewise, Tucker's coefficient of congruence was well above the .85 threshold: it was .98 and .99 for factor 1 and 2, respectively. Overall, then, the two-dimensional factor structure uncovered in Study 1 was well replicated.

Table 4.
Comparison of factor structure

	Study 1		Study 2			
Component Abbreviations	**Kindhood**	**Naturalness**	**Kindhood**	**Naturalness**	Squared Difference	Volatile?
-EnvE	-0.21	**0.66**	-0.03	**0.6**	0.03	
IntC	0.23	**0.81**	0.23	**0.75**	0.01	
-BouD	-0.02	**0.87**	0.06	**0.8**	0.00	
-InvT	-0.32	**0.92**	-0.24	**0.93**	0.00	
Immu	0.16	**0.67**	0.28	**0.65**	0.00	
-Flex	0.08	**0.75**	0.16	**0.72**	0.00	
EnvL	**0.81**	0.24	**0.85**	0.1	0.00	
Excl	**0.65**	0.25	**0.29**	0.05	0.13	Yes
Disc	**0.60**	0.08	**0.72**	-0.06	0.01	
Info	**0.66**	0.02	**0.75**	0.05	0.01	
-Hete	**0.87**	-0.13	**0.86**	-0.05	0.00	
IndP	**0.88**	0.15	**0.91**	0.05	0.00	
Inhe	**0.97**	-0.09	**0.99**	-0.15	0.00	

ForE	**0.79**	0.15	**0.75**	0.16	0.00

Note. **Bold** indicates largest loading. Shading for Study 2 indicates where the bold is expected. Volatile is indicated by a squared difference greater than .04. Values have been rounded to the one-hundredth place.

The different methods of cluster analysis once again converged on 4 clusters (Figure 3), which again conformed to natural kinds, artifacts, social roles, and naturalized social categories, with only a few items in unexpected clusters. The relative position of these category domains was highly similar to Study 1 as can be seen by how closely the clusters overlap when combining stimuli from Study 1 and 2. Therefore, we also replicated the cross-domain comparisons.

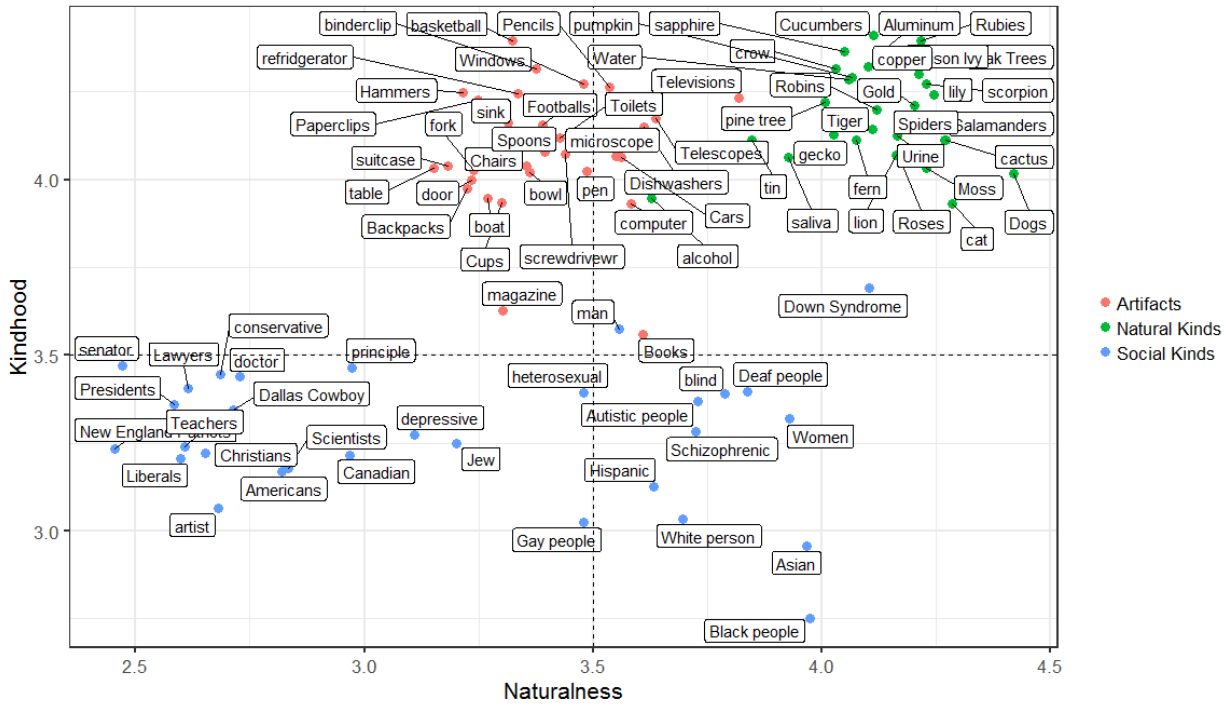

Figure 3. Overlay of Study 1 and 2 stimuli. We color-coded items by pre-conceived domain.

Next, we report the confirmatory factor analysis fit indices (with thresholds in parentheses): chi-square, $\chi^2 = 143.69$, $df = 76$, $p < .001$ ($p > .05$ or alternatively $\chi^2 / df < 2.0$); RMSEA = .14 (< .08); CFI = .87 (>= .90); SRMR = .09 (< .08). Thus, our model falls short of most thresholds of acceptability for CFA. However, many psychological constructs exhibit robust and reliable exploratory factor structures but fail CFA tests – most famously the "big five"

personality model, which reliably emerges in exploratory factor analysis but often fails CFA tests (Marsh, et al., 2010). With greater numbers of items, especially non-synonymous items, minor cross loadings, minor variations in correlations can aggregate into more substantial deviations from the all-or-none structure CFA assumes. Critically, a model assuming naturalness and kindhood fits the factor structure markedly better than a model assuming a single latent variable, using a relative fit measure: Chi Square Difference Test, $\chi^2 = 99.57$, $p < .001$. A single latent variable model fails CFA tests much more egregiously, CFA thresholds: $\chi^2 = 613.57$, $df = 91$, $p < .001$ ($p > .05$ or $\chi^2/df < 2.0$); RMSEA = .22 (< .08); CFI = .68 (>= .90); SRMR = .16 (< .08).

Studies 1 and 2 show the robustness of the two-factor structure but also raise questions that cannot be fully adjudicated by correlational studies. In Study 3 we examined the inferential relationships between different beliefs about category structure. That is, we manipulated single properties of novel categories (e.g., inductive potential) and measured beliefs about the remaining properties.

Study 3

In study 3, we experimentally manipulated beliefs about category structure to examine the causal relationships between different beliefs. This study was pre-registered: https://osf.io/cjz8n/. During belief formation, and in everyday reasoning about categories, people appear to use observed features to infer other unobserved features, leading children and adults to construct increasingly rich category representations. One possibility is that all the beliefs associated with psychological essentialism mutually inform each other, leading people to construct essentialist representations (Rhodes et al., 2012; Rhodes & Mandalaywala, 2017). Another possibility is that people primarily make inferences between components of kindhood (e.g., inductive potential implies informativity) and between components of naturalness (e.g.,

intrinsic causes imply immutability; Noyes & Keil, 2019; 2020). I.e., upon observing one property of kindhood observers might infer other components of kindhood also apply but might not assume that components of naturalness also apply (and vice versa upon observing an initial component linked to naturalness). Such a pattern would support the explanatory power of the two-factor structure we observed in Studies 1 and 2.

Method

4.1.1. Participants

Data was collected on Prolific. We aimed for 50 participants per cell like Study 1 and 2, and so recruited 250 participants (251 participants actually completed the survey in the time allotted). The average age was 47.4 (*SD* = 17.5), gender breakdown was 51% women and 49% men, 73% of the sample was White.

4.1.2. Design and Procedure

In the task, participants learned about one aspect of the category (for example, they would learn that category members were homogenous or heterogenous); then, participants answered the remaining 13 items retained in Study 1 and 2. There was a "high" and a "low" condition for each of the components. For example, "*Suppose people thought an entity was a Zeb. People's beliefs would make it become more like a Zeb over time*" versus "*Suppose people thought an entity was a Zeb. People's beliefs would not make it become more like a Zeb over time.*" Participants were assigned to 6 of the possible 28 conditions but never received the *High* and *Low* condition of the same component.

4.1.3. Analysis Plan

We pre-registered two main analyses that were complementary to each other, both based on the hypothesis that the magnitude of within-factor effects (e.g., a manipulation to a

component of kindhood affecting another component of kindhood) will be stronger than the magnitude of between-factor effects (e.g., a manipulation of a component of kindhood affecting a component of naturalness). *Analysis 1*: We specified a multi-level model with relationship type (within vs. between factor) and experimental condition (*High* vs. *Low*) as fixed effects. To account for the nested structure of the data we specified random intercepts for participant, the item that was manipulated, and the item that that was measured after the manipulation. We predicted a significant two-way interaction such that the effect of experimental condition (*High* vs. *Low*) would be more influential within-factor than between. *Analysis 2*: We calculated a difference score between the *High* and *Low* condition for each of the items. We then performed a between subject t-test between within-factor pairs and between-factor pairs, using the difference scores as units of analyses. We predicted a significant effect such that within-factor difference scores would be larger on average than between.

4.2. Results and Discussion

We confirmed our hypotheses: The two-way interaction in the multi-level model was significant, $b = .24$, $SE = .04$, $p < .001$, such that inferences were stronger within-factor than between-factor. Likewise, the difference scores were larger within-factor than between factor, $t(160.83) = 3.96$, $p < .001$, $d = .60$ (Figure 4). The average within-factor effect was quite large, $d = .82$, whereas the average between-factor effect was moderately weak, $d = .37$. The kindhood factor, $d = .87$, and naturalness factor, $d = .76$, both had large within-factor causal effects.

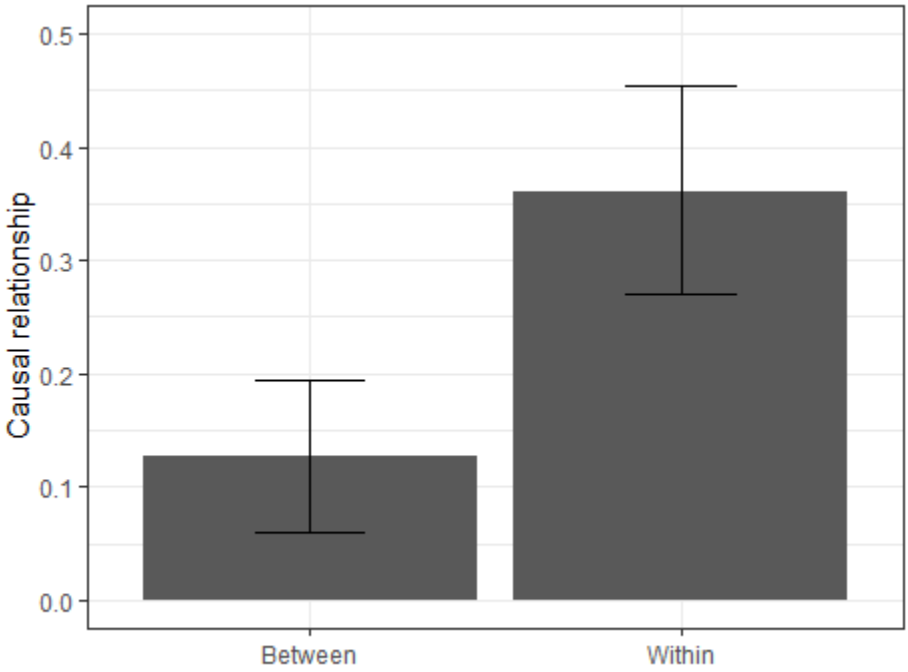

Figure 4. Average strength of for within- versus between-factor causal relationship. Error bars represent 95% bootstrapped confidence intervals.

Next, we separately examined the two between-factor causal relationships. We found that naturalness beliefs had a moderate relationship to kindhood beliefs, $d = .48$, but that kindhood beliefs had a weak relationship to naturalness beliefs, $d = .27$. That is, telling people a category had one aspect of kindhood only weakly increased their belief the category was natural but telling people a category had one aspect of naturalness moderately increased their belief that the category was a robust kind. Because there was a weak relationship between kindhood and naturalness, we wondered whether participants were systematically inferring natural kinds (as opposed to social kinds). First, we examined whether this relationship was statistically significant: We examined whether there was a significant effect of condition (high vs. low) for the kindhood to naturalness relationship; we used a multi-level model since there were multiple responses from each participant. We found a significant, small effect, $b = .08$, $SE = .04$, $p = .044$; based on the standardized beta, there was approximately a movement of .06 standard deviations

on naturalness after learning about aspects of kindhood. Critically though, this movement represented movement from significantly below the midpoint (M = 3.35) in the low kindhood condition to *non*-significantly below the midpoint for the high kindhood condition (*M* = 3.45). To see the comparisons to chance, see the bootstrapped confidence intervals in Figure 5 (left panel). Therefore, although we found a significant and nonzero relationship between kindhood and naturalness, there was no bias to infer kinds had essences; that is, at high kindhood, participants showed no tendency to believe the category was more natural than social (as indicated by the midpoint). Instead, participants were equally willing to infer kinds were social or natural.

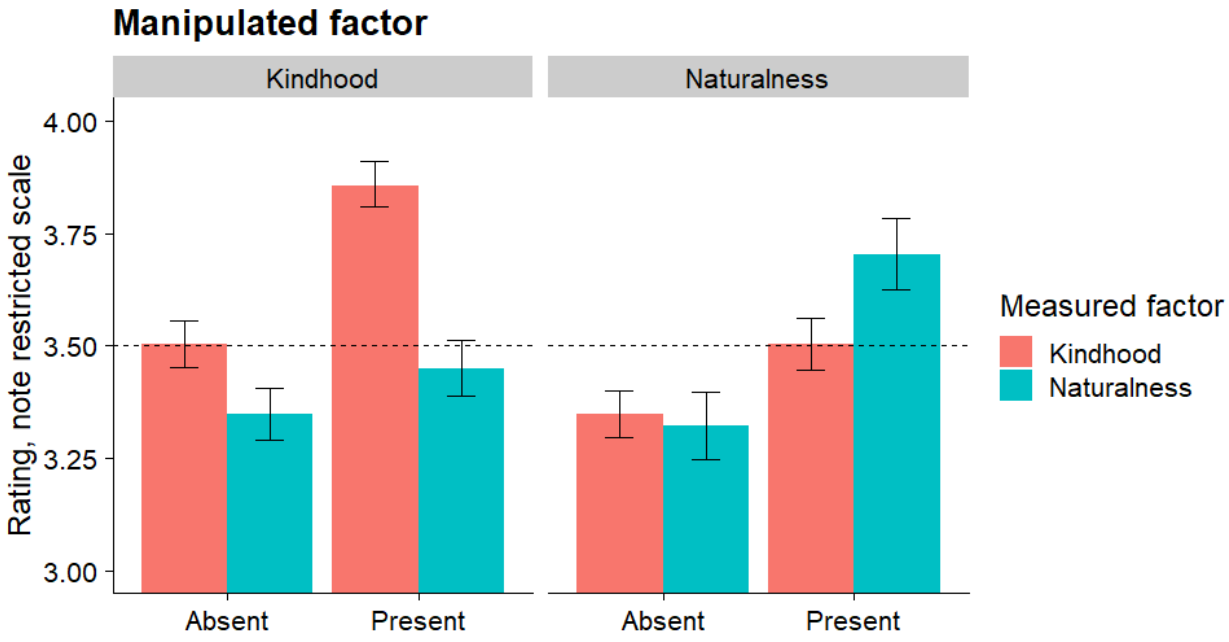

Figure 5. Average ratings of kindhood (red) and naturalness (teal) after learning that a novel category had (present) or lacked (absent) a single feature of kindhood (left panel) or naturalness (right panel). Error bars represent 95% bootstrapped confidence intervals. The midpoint of the scale is 3.50.

We then constructed a network graph of all of the non-negative and non-trivial (Cohen's *d* > .20) causal relationships (Figure 6), where each component occupies a node and each causal relationship is plotted via a directional edge. We color-coded edges to be blue for Kindhood,

yellow for Naturalness, and grey for between-factor. We used the Fruchterman-Reingold algorithm, which is a type of force-directed algorithm that tries to maintain equal edge width and minimize cross-cutting edges. Nodes end up being arranged by centrality, and so the clustering of the nodes and their position near or far from the center is meaningful. For example, IntC, IndP, and Flex, which were all highly central, are arranged within the middle of the figure. Specifically, IntC (*Xs have internal or microscopic properties that cause their characteristic appearance and behavior*) had the largest outbound effect, and had the strongest effect on other aspects of causal structure. The item with the largest inbound effect was Flex (*It is easy for an X to become a non-X*), and so was influenced the most by other aspects of category structure. The largest bidirectional effect was IndP (*Someone tells you a fact about an individual X. This fact is very likely true of other Xs as well*); this belief influenced many other aspects of category structure and was influenced by many other aspects of category structure. As can be seen, the nodes cluster together so that kindhood and naturalness formed two relatively distinct clusters, consistent with the greater causal strength within- than between-factor. Notably, kindhood appears as a much more coherent cluster of beliefs than naturalness.

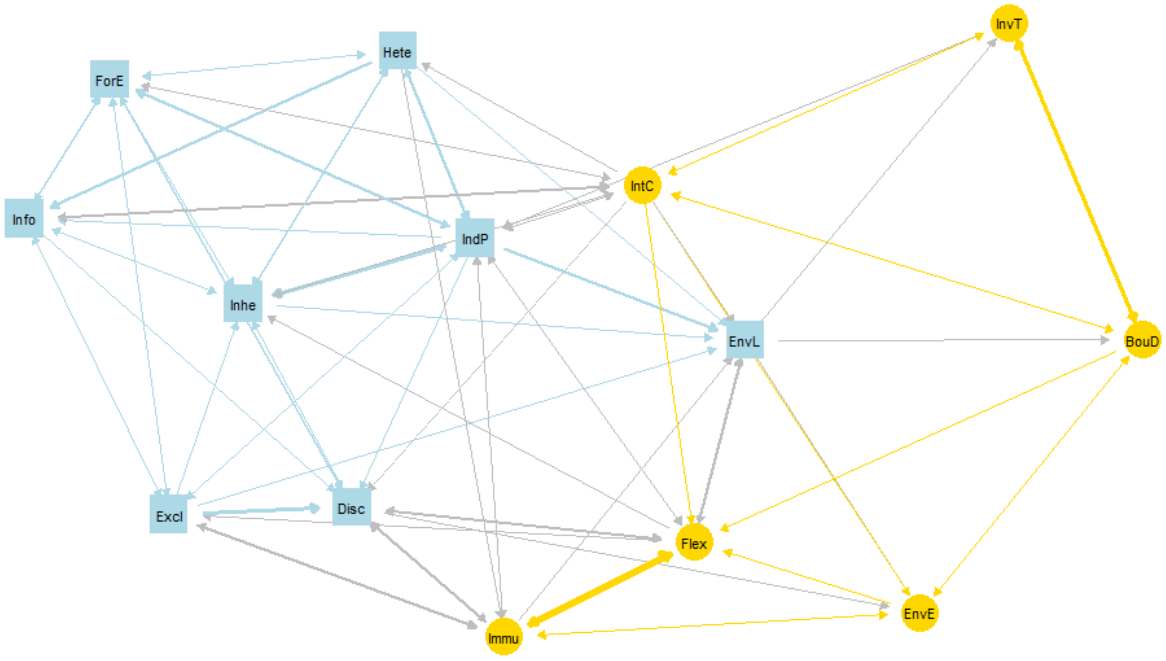

Figure 6. Network map of the causal relationships. Yellow = Naturalness, blue = Kindhood, grey = between-factor. Width = strength of the causal relationship. Only non-negative relationships with $d > .20$ are plotted. Network is generated by the Fruchterman Reingold algorithm. NOTE: The exact configuration is stochastic.

Study 3 offers one of the first comprehensive studies of the inferential relationships between different beliefs associated with kinds and their causal structure during belief formation.

Study 3 adds further support that naturalness and kindhood are distinct dimensions and that kinds can be social or natural. Telling participants that a category had one component of kindhood only very weakly influenced their beliefs about components of naturalness; participants did not show a bias to infer kinds in general were natural – consistent with recent work on generic language (Noyes & Keil, 2019; 2020).

Study 4

In Studies 1 and 2, the exploratory factor analysis was conducted on categories that may all be considered kinds, particularly when compared to truly contrived categories like 'people sitting in a chair right now.' Therefore, we undertook an additional exploratory factor analysis that included contrived categories. Half of the categories we examined were from the prior studies and included natural, artifactual, and social categories. The other half were contrived categories that also included contrived animal categories (e.g., 'Animals whose English name starts with C') and human categories (e.g., 'People whose last name starts with B'). If the kindhood dimension represents kindhood, then the majority of contrived categories should be low on kindhood regardless of what types of entities they included (e.g., people, objects, or animals). If naturalness and kindhood are truly distinct, then contrived categories should also vary in naturalness: https://osf.io/ea29b.

5.1 Method

5.1.1. Participants

We recruited 400 participants on Amazon Mechanical Turk. We did not collect demographic data.

5.1.2. Materials and Procedure.

Category Selection. We retained 20 categories from Studies 1 and 2: *Tiger, robin, spider, oak tree, copper, Black person, woman, lawyer, Asian person, New England Patriot, schizophrenic person, Senator, Deaf person, principal, president, hammer, chair, football, paperclip, table.* We choose 20 contrived categories: *Person who can't curl their tongue, animal with spots, animal that could be in a tree, animal that is wet right now, animal with some kind of tail, animal whose English name starts with C, person with a mole on their left shoulder, person with brown eyes, person who has narrow ear lobes, person whose second toe is the longest toe, person wearing pants today, person whose last name starts with B, person born on the second week of their birth month, person with two uncles, person sitting in a chair at this exact moment, thing weighing more than a bowling ball, thing you could find in a parking lot, thing people don't eat, thing that looks like a face, thing that has been painted white.*

2.1.2.2. Category structure judgments. We included the full set of items originally used in Study 1 with some modifications. Specifically, we added several items suggested by an anonymous reviewer. First, we asked participants about their deference to experts: *An expert is needed to conclusively determine if something is an X*. Second, we introduced a domain-general version of inheritance that could be asked about other categories, including non-biological kinds: *Xs today acquired properties from the X that came before.* Finally, we added a question about the possibility of discovering new properties of category members*: One day we may discover something that has always been true of Xs that we did not know before.*

We removed four items. We removed the reality questions (ReIm, -ReLa, -ReBe) as they were not prominent in prior enumerations of beliefs associated with psychological essentialism, showed low correlations with other items, and were at ceiling in Study 1 and so would likely produce ceiling judgments again. We removed the mutual-exclusivity question (Excl) because

the item was vaguely worded and proved volatile in Studies 1 and 2; further, we found it difficult to remove the vagueness without explicitly referencing a contrast category (e.g., If an animal is a tiger, then it cannot also be a lion). However, providing a contrast category was problematic for contrived categories, as contrived categories lack obvious contrasts (e.g., 'animal with spots' could be contrasted with 'animal without spots' or 'animal with stripes,' but these two contrasts might produce wildly different intuitions).

2.1.2.3. Factor Analysis Plan. *Data Collection*. We planned to conduct our factor analysis with categories as the unit of analysis. Participants were randomly assigned to respond to 12 judgments and 10 categories per judgment. The exploratory factor analysis was conducted as explained in Study 1.

5.1. Results and Discussion

Parallel analysis suggested a three-factor solution. The third factor was a surprising addition compared to prior work and Studies 1 and 2 but this was also the first study to include non-kinds. We decided to handle the third factor in the following manner: First, we examined a two-factor solution to see whether those factors resembled the naturalness and kindhood dimensions from Studies 1 and 2. We did this to answer our primary question, which is whether the kindhood dimension extracted in Studies 1 and 2 diagnosed kinds or non-social categories. Second, we explored the third factor to try to better understand it and to examine whether it qualifies any of the conclusions reached above.

Two-factor solution

The 2-factor solution looked similar for Oblimin and Promax; we report Promax because the factor loadings were slightly better with respect to above-threshold loadings and lack of cross-loadings.

Factor 1 captured 32% of the total variance. The following items had loadings above 0.60 and positive cross-loadings under 0.30: Capacity to support formal explanations (.97; ForE), homogeneity (.96; -Hete), informativity (.89; Info), shared structure (.85; Inhe), inductive potential (.85; IndP), capacity to be studied by scientists (.754; SciH), stability of category-linked properties over time (.65; StaP), and domain-general propagation of properties across generations (.62; Herit). Finally, consistency in properties over locations (EnvL) had a factor loading of 0.58, and was one of the items retained in studies 1 and 2. Therefore, 6 / 7 of the beliefs that loaded on the original kindhood measure loaded highly here (5 above threshold, 1 just below), suggesting that this factor is indexing kindhood. One item deviated strongly from studies 1 and 2: The belief that category membership is discrete (-0.15; Disc). By their nature, many non-kinds have discrete boundaries: e.g., 'people with two uncles' and 'animals whose English name starts with C.' Therefore, it makes sense that in this set of categories, discreteness was no longer associated with kinds. This highlights the general need to consider beliefs in the context of the comparison set.

Factor 2 captured 25% of the variance and had a weak correlation to Factor 1 (0.22). The following items had loadings above 0.60 and positive cross-loadings under 0.30: possessing non-legislated category boundaries (.92; -BouD), existing independent of human invention (.88; -Invt), being un-affected by people's beliefs (0.76; -EnvE), possessing properties sufficient for category membership (Suff; 0.69), possessing objective boundaries (-BouO), and affording discovery (Discovery; 0.61). Internal causes (0.71; cross-loading: .45; IntC), inflexible membership (0.62; cross-loading: .33; -Flex), and immutability (0.57; cross-loading: .33; Immu) also loaded onto the naturalness dimension, as in Studies 1 and 2; two of these items had just-above threshold cross-loadings but IntC cross-loaded more substantially. Thus, Factor 2 broadly

resembled the naturalness dimension observed in Studies 1-2 but the profile of loadings was less well-formed. We suspect this is because of the inclusion of non-kinds, which by their nature have disorganized causal structures. For example, *Animal that is wet right now* is technically mind-independent because being wet is not constituted by people's intentions, nor are the majority of animals wet because of humans. But clearly category membership is neither immutable nor inflexible: The animal simply needs to dry off. The interpretation of this dimension as roughly corresponding to the naturalness dimension observed in Studies 1 and 2 is further supported by variation in the categories included. As before, artifacts and social roles were low on this dimension and naturalized social categories and natural kinds were high. In sum, the naturalness dimension was less organized in the presence of non-kinds; nevertheless, the dimension overall approximated something roughly consistent with the naturalness dimension identified earlier.

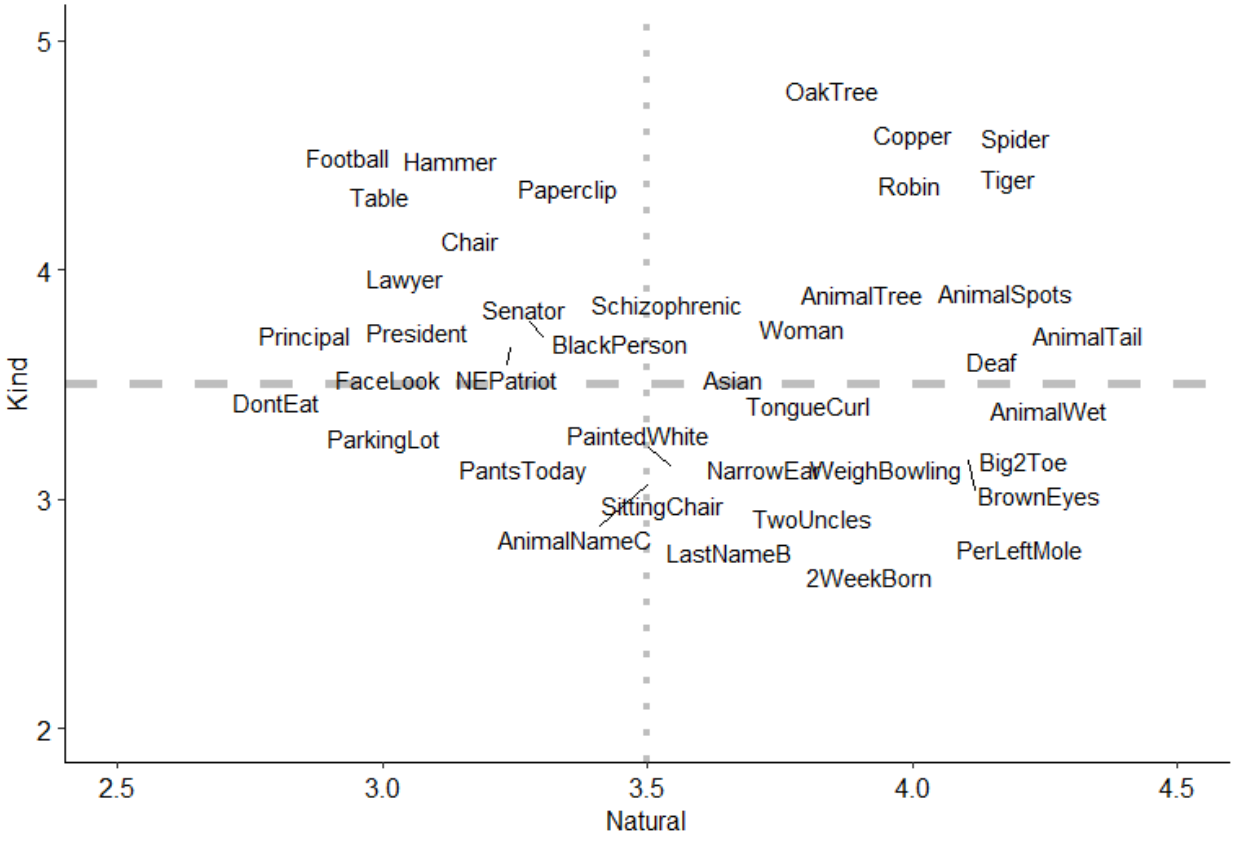

Figure 7. A plot of the categories in the two-factor space, naturalness by kindhood.

Consistent with our interpretation of kindhood, Factor 1 revealed a three-tiered variation, with the majority of the non-kinds in the bottom tier below the midpoint, social categories just above the midpoint, and artifacts and natural kinds high above the midpoint. Non-kinds that included animals, people, and objects were in the bottom layer. Therefore, we see little indication that the kindhood dimension in Studies 1 and 2, which overlapped substantially with Factor 1 in this study, was merely tracking the distinction between social and non-social categories. We also see that all three layers of variation varied in naturalness, with categories like *footballs*, *principals*, and *things you can find in a parking lot* low in naturalness but varying in kindhood, and categories like *tigers*, *Deaf people*, and *people with brown eyes* high in naturalness but varying in kindhood.

Third dimension

In the context of a three-factor solution, Factor 1 accounted for 30% of variance, Factor 2 accounted for 21% and Factor 3 accounted for 15% of the variance. The following items loaded onto Factor 1 (>.60, no cross-loading >+.30): Stability of properties (StaP), homogeneity (-Hete), inductive potential (IndP), shared structure (Inhe), support formal explanations. The following items loaded onto Factor 2: Not influenced by people's expectations (-EnvE), non-legislated boundaries (-BouD), culturally-independent boundaries (-BouC), objective boundaries (-BouO). Overall, then, Factor 1 and 2 roughly approximated kindhood and naturalness – though, in this three-factor solution, Factor 2 contained only reverse coded items, suggesting the three-factor solution was more responsive to methodological properties (scale usage) than substantive properties of the stimuli, raising the possibility that the third factor is an artifact related to question wording.

Nonetheless, four items loaded on Factor 3: Discovery (.84), appearance-reality distinction (.74; ApTr), deference to experts (.58), and scientific history (.65; SciH). Interpretation of this factor should be cautious given its lack of precedence, the fact that it explains the least variation, and its relatively low factor loadings. Indeed, by our pre-registered criteria, it is ambiguous how we ought to handle it. Parallel analysis suggested three factors, and we pre-registered prioritizing parallel analysis to determine the number of factors to extract. On the other hand, the low number of items, the relatively weak factor loadings of those items, and the *a priori* considerations in favor of two or one factors, suggests eliminating it. That said, the items that did load on it have a plausible interpretation. A distinction between appearance and reality, deference to experts to determine category membership, ability to make open-ended discoveries, and capacity of scientists to study the origins of the category, all suggest the sort of kind that prior authors have characterized as having or being perceived as having "inexhaustible

structure" (Gelman & Markman, 1986): i.e., scientists can consistently study *tigers* without exhausting the possibility of learning new facts about them. Given that two of the items that loaded on this factor were present only in this study suggests the appearance of a third factor is not necessarily at odds with results of the other studies reported here; it could be the case that there is a genuine third cluster or dimension of beliefs lingering among beliefs associated with psychological essentialism not quite captured by current measures but relating to the idea of inexhaustible structure. In future research, it would be helpful to try to flesh out this factor by including a greater diversity of items directly tied to theorizing about inexhaustible structure and the possibility of supporting scientific inquiry and discovery.

Indeed, Gelman & Markman (1986) suggested that this kind of inexhaustible structure delineates natural kinds and artifacts – whereas features like homogeneity and informativity do not. As described above, we did find that natural kinds and artifacts were equivalent on kindhood (which included homogeneity and informativity). Does this third factor distinguish natural kinds and artifacts as Gelman & Markman (1986) predict? To see whether this was the case, we used Ward Hierarchical Clustering to identify categories high and low on this dimension. Consistent with Gelman & Markman (1986), every natural kind was in the 'high' group (tiger, robin, oak tree, copper, spider) and every artifact was in the 'low' group (paperclip, hammer, football, chair, table). Therefore, Factor 3 may represent precisely the dimension they had in mind as giving natural kinds a special status over artifacts. Consistent with this interpretation, 80% (16 / 20) of the non-kinds were also in the 'low' group as they would have predicted as well. Notably, however, 70% of the social categories (7 / 10) were in the 'high' group and this included both institutional roles (president, senator, lawyer, New England patriots) and naturalized social categories (Asian, Deaf, Schizophrenic). If we take Factor 3 seriously, this hints at the interesting

possibility that inexhaustible structure may generalize to institutional kinds (Noyes, Dunham, Keil, & Ritchie, *in press*). This is likely because institutional roles are embedded in complex social structures that individuals have less direct intentional control over by virtue of being distributed across many individuals and across time, such that institutions give rise to emergent and complex processes and thereby support the possibility of continued discovery as to their nature. In contrast, the properties of artifacts involve less complex external structures and dependencies on social processes (and less complex internal structures than natural kinds) and individuals have more direct control over the properties of artifacts.

In sum, Factor 3 points to a possible third dimension of beliefs. This dimension delineates natural kinds and social categories from artifacts and non-kinds, which differs from the variation observed for kindhood or naturalness. As noted, Factor 3 should be interpreted cautiously and it will require future empirical research to establish the replicability and reliability of this factor. Nevertheless, it does comport well with theoretical distinctions made in prior work that are not currently captured by the naturalness and kindhood dimension. However, even if Factor 3 is taken seriously, it offers little to support the idea that psychological essentialism coheres as a 'natural kind syndrome' both because it suggests even more differentiated structure and because natural kinds and institutional roles were both high in this dimension despite varying considerably in naturalness.

General Discussion

Four studies demonstrated that *kindhood*, the perceived coherence and cognitive utility of a category, is largely independent from *naturalness*, the extent to which a category and its properties are taken to depend on natural or social processes. These results strongly suggest that psychological essentialism is not a cluster or 'family resemblance' concept with various sub-

components. Rather, kindhood and naturalness are distinct clusters of beliefs with their own sub-components, and there is little empirical rationale for considering kindhood and naturalness two facets of some higher-order construct.

A major advance over prior research is the inclusion of multiple distinct category domains. As depicted in Figure 1, prior research focusing solely on social categories was unable to distinguish between quite different models of how beliefs associated with psychological essentialism relate to each other. For example, the most prominent model of psychological essentialism as a 'natural kind syndrome' suggests that these beliefs are present for natural kinds and absent for contrived categories, and correlate strongly when considered in the context of several major category domains. But the evidence presented here does not support the assumptions of this model. Including more categories instead reveals the stability of the two-factor solution and the weak relationship between naturalness and kindhood. Critically, in the two-dimensional space defined by kindhood and naturalness, categories do not tend to fall along the diagonal but rather vary widely, with both natural and social categories robustly present at every 'tier' of kindhood.

A second major advance is the experimental approach in Study 3. We saw that inferential relationships were strong within a dimension (i.e., among components of kindhood and among components of naturalness). But the inferential relationships were weaker between kindhood and naturalness. Telling participants that a category had a component of kindhood lead them to infer other aspects of kindhood but it did not lead them to infer other aspects of naturalness. Similarly, telling participants that a category had a component of naturalness lead them to infer other aspects of naturalness, but it did not lead them to infer other aspects of kindhood. Thus, the

pattern of inferential relationships further supports the independence of these two clusters of beliefs.

We also provide one of the few studies to empirically examine contrived categories such as "people sitting in a chair right now" in relationship to major, familiar category domains (see also Ahn, Taylor, Kato, Marsh, & Bloom, 2013). Although contrived categories are prominent in early proposals relating to psychological essentialism (e.g., Keil, 1989; Gelman, 2003), there has been little empirical work comparing kinds and contrived non-kinds. The inclusion of non-kinds helped to further demonstrate the coherence of kindhood as a dimension, and clarified that there are at least three tiers of variation, with social categories represented as kinds when contrasted with non-kinds but as more intermediate in kindhood when contrasted with animals and artifacts. The inclusion of contrived categories also demonstrated that people represent many contrived categories as natural, showing that naturalness is less an outcome of viewing a category as a kind than an interpretation of the structure of specific properties.

Limitations

A strength of the current project was the inclusion of diverse categories from several major domains. Nevertheless, a methodological limitation inherent to data-driven approaches like exploratory factor analysis is that the result depends on the initial conditions: What items we include (or fail to include) and what set of categories we decide to test (and which we leave out) will influence the patterns we observe. We observed the impact of some of these decisions in the comparison between Studies 1-2 and Study 4. The inclusion of additional items and non-kinds lead to some shifts in factor structure and opened the possibility of a third factor, though we still think Study 4 was consistent with the more parsimonious two-factor structure. Nonetheless, these limitations suggest that we cannot claim to have uncovered the definitive structure of these

beliefs. In fact, we suggest there is no single definitive structure: The relationship between these beliefs necessarily depends on the categories being considered and the relationships between them; people's inferences are context dependent. Indeed, the set of categories relevant to ordinary cognition is indefinitely large and the set of possible categories is infinite. However, although we think the inclusion of more diverse categories and items could reveal additional clusters, such as a cluster of 'inexhaustible structure' that supports scientific inquiry (as Study 4 hinted; see Gelman & Markman, 1986), the inclusion of anything other than a contrived set of items is unlikely to suggest that there is only a single factor. After all, we included the members of category domains most central to psychological essentialism; including categories further afield is unlikely to reveal a single 'natural kind syndrome.' Paradigmatic natural kinds and non-kinds are the presumed 'poles' of essentialist beliefs; seeing variation in the two-dimensional space even at these poles is sufficient to infer that these two dimensions are independent.

Another limitation concerns our ability to confidently categorize all beliefs we measured as distinctly related to kindhood or naturalness. This involves both methodological and conceptual issues. First, none of our measures are 'pure' tests of the beliefs we intended to measure; these measures are simply face-valid tests of the intended belief and each could be the subject of its own dedicated empirical project (indeed, most of beliefs we measured have been the subject of dedicated empirical projects; e.g., see Diesendruck & Gelman, 1999). Subtle issues with wording can make an item appear unrelated to naturalness or kindhood when it actually is a component of these belief clusters; subtle issues with wording could lead to artificial cross-loadings. We may have unintentionally included some double-barreled language in an attempt to clarify meaning. And, we had to sometimes rely on vague or syntactically unusual language to capture all categories tested with the same linguistic structures. A subset of the beliefs we

investigated may be conceptually multifaceted, such that they derive from multiple, intersecting intuitions (and may even derive from different intuitions across contexts, as different contexts may highlight different intuitions). Having said that, we think those beliefs that reliably loaded in Studies 1, 2, and 4, and which showed strong within-cluster inferential relationships in Study 3, are probably reliable and indicative of a general two-factor structure consisting of kindhood and naturalness.

Future Directions

There remains an open possibility that representations that combine the assumption of naturalness and kindhood (i.e., natural kinds) have unique features, and models of psychological essentialism often do represent essentialist representations as having two major facets (the kind assumption and the essence assumption; Gelman, 2003). But, the possibility of their convergence, and possible unique effects of their converge, does not justify measurement strategies, theoretical conclusions, or empirical projects that treat them as a unitary phenomenon rather than a significant intersection of two distinct phenomena. Unique effects likely also emerge for combinations of kindhood and the assumption of social or institutional structure, a fascinating direction for future study.

What are kindhood and naturalness in the mind?

Our studies further suggest kind representations are a psychologically real type of concept. We found that core aspects of kindhood were reliably and strongly correlated and revealed a dense network of inferential relationships. A kind has several core component beliefs: People represent members as sharing properties and causal-explanatory structure responsible for those properties, people represent the category as informative and inductively potent, and people use the category in formal explanations. The strong interdependence of these beliefs is consistent

with theoretical proposals beyond essentialism, including the literature on principled connections (Prasada & Dillingham, 2009), structural explanations (Vasilyeva et al., 2018; Vasilyeva & Lombrozo, 2020), and institutional kinds (Noyes & Keil, 2019; 2020). Indeed, in one developmental study, all components of kindhood measured appeared to come online at the same time in development (Haward, Wagner, Carey, & Prasada, 2018), very much unlike beliefs about naturalness, which are initially uncorrelated (Gelman, 2003; Rhodes & Mandalaywala, 2017). Thus, unlike intuitive theories about category naturalness, which reflect a protracted and culturally contingent process of theory construction (Rhodes & Mandalaywala, 2017), kinds may be early-emerging and culturally universal species of concept with definite features. This possibility is consistent with recent theorizing: Carey (2009) proposes that people take kind language (such as noun labels) to refer to the 'same [natural] kind as that,' where natural means coherent but not necessarily naturally determined. Thus, all representations of kinds share a definite logical structure. Ritchie & Knobe (2020) also propose that people represent kinds via 'kind files' that function in a similar way; here too, all kind representations share the same representational structure. Even theorizing related to psychological essentialism considers kindhood the more primitive and fundamental component of essentialist reasoning (Gelman, 2003). Thus, empirical data and recent theorizing support a picture of kinds as a distinct type of concept that expresses a core of inferentially connected beliefs. Studying kinds in their causal-explanatory diversity may help us better understand this important type of concept.

Based on the evidence here, we think naturalness is unlikely to be a single set of coherent beliefs but rather a cluster or syndrome not unlike what has previously been proposed for essentialism writ large (Rhodes & Mandalaywala, 2017). But unlike 'essentialist beliefs,' naturalness beliefs do correlate reasonably well, possess strong inferential relationships to each

other, and are generally all present for naturally determined categories (e.g., tiger) and all absent for socially constructed ones (e.g., lawyer). Nevertheless, we should not expect people's intuitive theories of animals, plants, minerals, and diverse social categories (e.g., age, race, gender) to show the exact same profile of beliefs. Likewise, we should expect that beliefs related to naturalness will not initially converge in development, as their convergence depends on active theory construction during childhood (Rhodes & Mandalaywala, 2017).

Conclusion

We tested the relationship between diverse beliefs associated with psychological essentialism through exploratory factor analysis and experimental manipulations. Our studies revealed that these beliefs, though traditionally associated with psychological essentialism, are not uniformly 'essentialist.' People believe that diverse real-world structures can produce coherent and cognitively useful categories, which we call *kinds*. People believe that natural structures can produce kinds or single properties, such that there can be naturally determined but contrived categories built around those single properties (e.g., *people with brown eyes*). Thus, kindhood and naturalness are two distinct clusters of beliefs, and there is little reason to treat them as two facets of a single higher-order construct such as essentialism.

Works Cited

Ahn, W. K. (1998). Why are different features central for natural kinds and artifacts? The role of causal status in determining feature centrality. *Cognition*, *69*, 135-178.

Ahn, W. K., Flanagan, E. H., Marsh, J. K., & Sanislow, C. A. (2006). Beliefs about essences and the reality of mental disorders. *Psychological Science*, *17*(9), 759-766.

Ahn, W. K., Kim, N. S., Lassaline, M. E., & Dennis, M. J. (2000). Causal status as a determinant of feature centrality. *Cognitive Psychology*, *41*, 361-416.

Ahn, W. K., Taylor, E. G., Kato, D., Marsh, J. K., & Bloom, P. (2013). Causal essentialism in kinds. *The Quarterly Journal of Experimental Psychology*, *66*, 1113-1130.

Barrett, P. (2007). Structural equation modelling: Adjudging model fit. *Personality and Individual differences*, *42*, 815-824.

Boyd, R. (1999). Homeostasis, species, and higher taxa. Species: New interdisciplinary essays, 141, 185.

Carey, S. (1996). Cognitive domains as modes of thought. Modes of thought: Explorations in culture and cognition, 187-215.

Cimpian, A., & Markman, E. M. (2011). The generic/nongeneric distinction influences how children interpret new information about social others. *Child development*, *82*(2), 471-492.

Coley, J. D., Arenson, M., Xu, Y., & Tanner, K. D. (2017). Intuitive biological thought: Developmental changes and effects of biology education in late adolescence. *Cognitive Psychology, 92*, 1-21.

Diesendruck, G., & Gelman, S. A. (1999). Domain differences in absolute judgments of category membership: Evidence for an essentialist account of categorization. *Psychonomic Bulletin & Review*, *6*, 338-346.

Diesendruck, G., Goldfein-Elbaz, R., Rhodes, M., Gelman, S., & Neumark, N. (2013). Cross-cultural differences in children's beliefs about the objectivity of social categories. *Child Development, 84*, 1906-1917.

Estes, Z. (2004). Confidence and gradedness in semantic categorization: Definitely somewhat artifactual, maybe absolutely natural. *Psychonomic Bulletin & Review*, *11*, 1041-1047.

Foster-Hanson, E., Leslie, S. J., & Rhodes, M. (2019). Speaking of kinds: How generic language shapes the development of category representations.

Gelman, S. A. (1988). The development of induction within natural kind and artifact categories. *Cognitive Psychology, 20,* 65-95.

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought*. New York, NY: Oxford University Press.

Gelman, S. A., & Markman, E. M. (1986). Categories and induction in young children. *Cognition*, *23*, 183-209.

Gelman, S. A., & Markman, E. M. (1987). Young children's inductions from natural kinds: The role of categories and appearances. *Child Development*, 1532-1541.

Gelman, S. A., & Rhodes, M. (2012). Two-thousand years of stasis. *Evolution challenges: Integrating research and practice in teaching and learning about evolution*, 200-207.

Gelman, S. A., Heyman, G. D., & Legare, C. H. (2007). Developmental changes in the coherence of essentialist beliefs about psychological characteristics. *Child development*, *78*, 757-774.

Gelman, S. A., Ware, E. A., & Kleinberg, F. (2010). Effects of generic language on category content and structure. *Cognitive Psychology*, *61*, 273-301.

Haslam, N., Bastian, B., & Bissett, M. (2004). Essentialist beliefs about personality and their implications. *Personality and Social Psychology Bulletin*, *30*, 1661-1673.

Haslam, N., Rothschild, L., & Ernst, D. (2000). Essentialist beliefs about social categories. *British Journal of Social Psychology*, *39*, 113-127.

Haward, P., Wagner, L., Carey, S., & Prasada, S. (2018). The development of principled connections and kind representations. *Cognition*, *176*, 255-268.

Hayton, J. C., Allen, D. G., & Scarpello, V. (2004). Factor retention decisions in exploratory factor analysis: A tutorial on parallel analysis. *Organizational research methods*, *7*(2), 191-205.

Hussak, L. J., & Cimpian, A. (2019). "It feels like it's in your body": How children in the United States think about nationality. *Journal of Experimental Psychology: General*, *148*(7), 1153.

Kalish, C. W. (1995). Essentialism and graded membership in animal and artifact categories. *Memory & Cognition*, *23*, 335-353.

Keil, F. C. (1989). *Concepts, kinds, and cognitive development*. Cambridge, MA: MIT Press.

Keller, J. (2005). In genes we trust: the biological component of psychological essentialism and its relationship to mechanisms of motivated social cognition. *Journal of personality and social psychology*, *88*(4), 686.

Kline, R. B. (2015). *Principles and practice of structural equation modeling.* Guilford publications.

Knobe, J., Prasada, S., & Newman, G. E. (2013). Dual character concepts and the normative dimension of conceptual representation. Cognition, 127(2), 242-257.

Leslie, S. J. (2013). Essence and natural kinds: When science meets preschooler intuition. Oxford studies in epistemology, 4, 108-165.

Lorenzo-Seva, U., & Ten Berge, J. M. (2006). Tucker's congruence coefficient as a meaningful index of factor similarity. *Methodology*, *2*, 57-64.

Malt, B. C. (1990). Features and beliefs in the mental representation of categories. *Journal of Memory and Language*, *29*, 289-315.

Malt, B. C. (1994). Water is not H2O. *Cognitive psychology*, *27*(1), 41-70.

Martin, C. L., & Parker, S. (1995). Folk theories about sex and race differences. *Personality and Social Psychology Bulletin*, *21*(1), 45-57.

Medin D.L., Ortony, A., (1989). Psychological essentialism. *Similarity and Analogical Reasoning*, eds Vosniadou S, Ortony A (Cambridge Univ Press, Cambridge), pp 21-59.

Medin, D. L., Lynch, E. B., Coley, J. D., & Atran, S. (1997). Categorization and reasoning among tree experts: Do all roads lead to Rome?. *Cognitive psychology*, *32*(1), 49-96.

Noyes, A., Dunham, Y. (2017). Mutual intentions as a causal framework for social groups. *Cognition*, 162, 133-142.

Noyes, A., Dunham, Y. (2020). Groups as institutions: The use of constitutive rules to attribute group membership. *Cognition*, 196, 104-143.

Noyes, A., Keil, F. C. (2019). Generics designate kinds but not always essences. *Proceedings of the National Academy of Sciences*, 116, 20354-20359.

Noyes, A., Keil, F. C. (2020). There is no privileged link between kinds and essences early in development. *Proceedings of the National Academy of Sciences*, *117*, 10633-10635.

Noyes, A., Keil, F. C., Dunham, Y. (2020). Institutional actors: Children's emerging beliefs about the causal structure of social roles. *Developmental Psychology*.

Noyes, A., Keil, F.C., Dunham, Y. (2018). The emerging causal understanding of institutional objects. *Cognition*, 170, 83-87.

Osborne, J. W., & Fitzpatrick, D. C. (2012). Replication analysis in exploratory factor analysis: What it is and why it makes your analysis better. *Practical assessment, research, and evaluation*, *17*(1), 15.

Prasada, S., & Dillingham, E. M. (2009). Representation of principled connections: A window onto the formal aspect of common-sense conception. *Cognitive Science*, *33*, 401-448.

Prentice, D. A., & Miller, D. T. (2006). Essentializing differences between women and men. *Psychological Science*, *17*, 129-135.

Prentice, D. A., & Miller, D. T. (2007). Psychological essentialism of human categories. *Current Directions in Psychological Science*, *16*, 202-206.

Rhodes, M., & Gelman, S. A. (2009). A developmental examination of the conceptual structure of animal, artifact, and human social categories across two cultural contexts. *Cognitive Psychology*, *59*, 244-274.

Rhodes, M., & Mandalaywala, T. M. (2017). The development and developmental consequences of social essentialism. Wiley Interdisciplinary Reviews: *Cognitive Science*, *8*, e1437.

Rhodes, M., Leslie, S. J., & Tworek, C. M. (2012). Cultural transmission of social essentialism. Proceedings of the National Academy of Sciences, *109*, 13526-13531.

Rips, L. J. (2001). Necessity and natural categories. *Psychological Bulletin*, *127*, 827.

Ritchie, K., & Knobe, J. (2020). Kindhood and essentialism: Evidence from language. *The Development of Social Essentialism*, *59*, 133.

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive psychology*, *8*(3), 382-439.

Rothbart, M., & Taylor, M. (1992). Category labels and social reality: Do we view social categories as natural kinds? In G. R. Semin & K. Fiedler (Eds.), *Language, interaction and social cognition* (pp. 11-36). Thousand Oaks, CA, US: Sage Publications, Inc.

Smyth, K., Feeney, A., Eidson, R. C., & Coley, J. D. (2017). Development of essentialist thinking about religion categories in Northern Ireland (and the United States). *Developmental Psychology*, *53*, 475.

Susan, C. (2009). *The origin of concepts.* Oxford: Oxford University Press.

Taylor, M. G., Rhodes, M., & Gelman, S. A. (2009). Boys will be boys; cows will be cows: Children's essentialist reasoning about gender categories and animal species. *Child Development*, *80*, 461-481.

Tucker, L. R. (1951). *A method for synthesis of factor analysis studies.* (Personnel Research Section Report No. 984). Washington, DC: Department of the Army.

Vasilyeva, N., & Lombrozo, T. (2020). Structural thinking about social categories: Evidence from formal explanations, generics, and generalization. *Cognition*, *204*, 104383.

Vasilyeva, N., Gopnik, A., & Lombrozo, T. (2018). The development of structural thinking about social categories. *Developmental Psychology*, *54*, 17-35.