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Asymmetric Mixtures: Common Conceptual Priorities for Social and Chemical Kinds

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Abstract

Hypodescent is the phenomenon of categorizing biracial individuals asymmetrically (e.g., viewing Black-White biracial individuals as Black instead of White). We propose that hypodescent is explained by domain-general attentional biases toward dangerous and distinctive components in conceptual representation. This cognitive mechanism derives its empirical support from several research traditions, especially from research on how people evaluate generic statements. Here, we demonstrate how liquid mixtures are categorized in ways characteristic of hypodescent. Mixtures that contain equal amounts of two liquids are categorized as whichever liquid is more dangerous or distinctive (Study 1). Dangerous and distinctive components are prioritized even when they are less than 50% of the mixture (Study 2). The relative dangerousness or distinctiveness of liquids (Study 3) or racial groups (Study 4) predicts the strength and direction of this asymmetry. We discuss how conceptual prominence relates to previous theories of hypodescent.

Keywords

social cognition, social categories, hypodescent, race, categorization, open data, open materials

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Under the Racial Integrity Act of 1924, the state of Virginia required all individuals to be classified as "White" or "colored." This legislation cemented a view of race with roots in the 17th century: the infamous "one-drop rule," wherein individuals were classified as "colored" if they had any traceable African or Native American ancestry (Hickman, 1997). This pattern of racial categorization persists in pronounced—if less extreme—ways (Halberstadt, Sherman, & Sherman, 2011; Ho, Sidanius, Levin, & Banaji, 2011; Peery & Bodenhausen, 2008). In a phenomenon known as hypodescent, people categorize biracial individuals as belonging more to minority racial categories than to majority ones. For example, Barack Obama was described as Black, despite common knowledge that his mother is White.

Two primary accounts of hypodescent have been proposed: the *attentional account* (Halberstadt et al., 2011) and the *motivational account* (Ho et al., 2011). According to the attentional account, hypodescent emerges from an individual's learning history (Halberstadt et al., 2011; see Kruschke, 1992; Nosofsky, 1986); people are first exposed to common (i.e., majority) exemplars when learning about a category. Then, as they encounter uncommon (i.e., minority) exemplars, attention shifts toward their distinguishing features—influencing subsequent category judgments (Halberstadt et al., 2011). Thus, minority racial features are weighted more than majority racial features when deciding someone's race. On the other hand, according to the motivational account, hypodescent emerges because of racial biases (Ho, Roberts, & Gelman, 2015; Ho et al., 2011). For example, White people categorize individuals as White to preserve the purity of the in-group or to stabilize the racial hierarchy (Castano, Yzerbyt, Bourguignon, & Seron, 2002; Ho et al., 2011; Rozin & Royzman, 2001). Thus, Black and Asian prejudice motivates White people to exclude biracial individuals from the White majority.

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Both accounts provide important foundations for understanding hypodescent, each with some support in the literature. Halberstadt and colleagues (2011) induced hypodescent for novel groups by manipulating exposure frequency, consistent with the idea that attention shifts toward unfamiliar features cause hypodescent. However, hypodescent may also arise from racial bias; Ho and colleagues (2011) found that Black-White hypodescent is stronger than Asian-White hypodescent. Familiarity cannot explain this finding because Black individuals are more represented in the media (Smith et al., 2015) and the general population (American Community Survey, 2015). However, this finding is consistent with the motivational account, because Black individuals are lower status (Fang, Sidanius, & Pratto, 1998; Kahn, Ho, Sidanius, & Pratto, 2009; Sidanius & Pratto, 1999).

Here, we outline an extension of the attentional account, based on conceptual prominence. Building on the generics literature, we propose that general attentional biases interact with other conceptual processes to cause hypodescent. Generics are a class of unqualified generalizations, such as "mosquitos carry West Nile virus." When assessing the truth of generics, people weigh properties in proportion to their conceptual prominence rather than their statistical frequency (Cimpian, Brandone, & Gelman, 2010; Cimpian, Gelman, & Brandone, 2010; Gelman & Bloom, 2007; Leslie, 2008). For example, less than 1% of all mosquitos carry West Nile virus, yet people accept the statement "mosquitos carry West Nile virus."

Certain types of properties are more striking or attention grabbing, such as those perceived as dangerous or distinctive (Cimpian, Brandone, & Gelman, 2010; Cree, McNorgan, & McRae, 2006; Leslie, 2008; LoBue, 2009; Öhman, Lundqvist, & Esteves, 2001). Thus, even when they are a rare feature of a category, distinctive and dangerous properties are prominent in conceptual representation, leading them to be generalized disproportionately. Ultimately, people generalize properties in ways consistent with their causal theories; people assume all mosquitos share the disposition to carry West Nile virus (Leslie, 2008), which permits the generalization. In the case of race, to the degree that minority features are perceived as more distinctive or dangerous, minority ancestry is a better explanation of biracial individuals' prominent features than White ancestry; thus, people tend to categorize biracial individuals as members of minority categories—even when ancestry information is known.

Thus, the generics literature shows how selective attention can combine with other conceptual processes (such as causal reasoning) to create asymmetric conceptual judgments. Whereas the standard attentional account (Halberstadt et al., 2011) is based on attention shifts in category learning, general attentional biases toward distinctive and dangerous properties may also lead to category asymmetries. Additionally, attention may interact with causal reasoning, bearing on evidence that causal theories influence hypodescent (Ho et al., 2015) and that explicit hypodescent is not reducible to attention alone (Roberts & Gelman, 2015). Nevertheless, we consider our account an extension of the prior attention account because both accounts are explicitly domain general and rely on how asymmetries in attention influence categorization.

As for motivational accounts, our proposal builds on different cognitive mechanisms but is potentially compatible. Racism surely helps explain why minority features are viewed as distinctive and dangerous in the first place, but these social-cognitive factors may work at least partly through basic cognitive processes rather than solely because of motivation or ideology. Nevertheless, the conceptual-prominence account predicts hypodescent-like effects in other domains. It predicts that hypodescent-like effects will occur wherever there are mixtures (e.g., liquid mixtures) as long as the domain has the right causal structure.

To test our account, we examined some of its novel predictions. First, we predicted that participants would asymmetrically categorize mixtures in domains in which racial factors are irrelevant. To test this idea, across three experiments, we examined the categorization of liquid mixtures. We predicted that participants would show characteristic patterns of hypodescent even in this radically different domain: For example, a mixture of equal parts apple juice and cyanide would be categorized as cyanide (Study 1), reflecting the greater danger and distinctiveness of cyanide compared with apple juice (Study 3). Indeed, people will tend to prioritize cyanide even when a higher proportion of the liquid mixture is apple juice (Study 2). Finally, we predicted that beliefs about distinctiveness and dangerousness would predict patterns of racial hypodescent, including biracial cases not examined before (Study 4).

Study 1

The aim of Study 1 was to explore whether people categorize liquid mixtures asymmetrically. This was an initial examination of whether liquids are subject to hypodescent-like effects.

Method

Participants. We expected a medium effect size (d = 0.5) on the basis of effect sizes seen in the literature on generic language (Cimpian, Brandone, & Gelman, 2010). We based our power analysis on the dependent t test between category judgments for distinctive-dangerous versus ordinary-benign categories; 50 participants would

Table 1. Asymmetric Categorization of Liquids (Study 1)

Liquid 1	Rating (1–6)	Liquid 2	Rating (1–6)	Difference	p	Cohen's d
Cranberry juice	4.09	Vodka	4.60	–0.51	.005	0.43 [0.01, 0.84]
Saline	3.89	Vicodin	4.38	–0.49	.045	0.30 [–0.11, 0.71]
Apple juice	3.61	Urine	4.85	–1.24	< .001	0.73 [0.35, 1.20]
Water	3.68	Cyanide	4.62	–0.94	.003	0.46 [0.04, 0.88]

Note: The table depicts how participants categorized ordinary-benign liquids (Liquid 1) versus distinctive-dangerous liquids (Liquid 2). Values in brackets are 95% confidence intervals.

give us approximately .90 power for this test. We recruited a sample of approximately 50 participants using Amazon Mechanical Turk. One participant was excluded for not completing the survey. This resulted in a final sample of 47 participants (25 men, 22 women). Participants received 40 cents for completing the survey.

Design and procedure. We selected four liquid pairs that we assumed were asymmetrically distinctive and dangerous: cranberry juice and vodka, apple juice and urine, saline and Vicodin, and water and cyanide. (This assumption was empirically confirmed in Study 3.) Participants read a brief description of each mixture: for example, "A person has a solution containing 50 ounces of cyanide and 50 ounces of water." Mixtures were always composed of equal parts of the component liquids.

Participants judged the category membership of the mixture by evaluating the truth value of two separate statements: "This liquid is a [*distinctive-dangerous category*]" and "This liquid is a [*ordinary-benign category*]" for each mixture. Each statement was rated on a 6-point Likert scale (*completely true* to *completely false*). This method permitted all possible responses; for example, people were able to classify the object as a member of both categories (rate both as true), neither (rate both as false), or anything in between.

Results

We expected that liquid mixtures would be categorized asymmetrically, specifically that they would be categorized as belonging to the distinctive-dangerous category more than the ordinary-benign category. First, we used a dependent t test to compare the average category judgment between distinctive-dangerous and ordinary-benign categories. This revealed a significant difference, $t(46) = 4.17$, $p < .001$, $d = 0.61$, 95% confidence interval (CI) = [0.19, 1.03]. Mixtures were rated as belonging more to the distinctive-dangerous category ($M = 4.61$, $SD = 1.09$) than to the ordinary-benign category ($M = 3.82$, $SD = 1.40$). Thus, people reported that it was mostly true that the mixture belonged to the distinctive-dangerous category but somewhere between slightly true and slightly false for belonging to the ordinary-benign category.

To model item as a random effect, which is more precise, we also employed a multilevel model on category judgments (completely false to completely true, 1–6) with distinctiveness-dangerousness (high vs. low) as a fixed effect and participant and item as random effects. This model corroborated the predicted effect of distinctiveness-dangerousness, $b = -0.79$, $SE = 0.10$, $p < .001$, $\beta = -0.60$.

We also examined whether there were differences between the items (Table 1). To do this, we analyzed the difference scores (distinctive-dangerous category score – ordinary-benign category score) using an analysis of variance (ANOVA) with item as the independent variable. The omnibus test was significant, $F(3, 184) = 7.43$, $p < .001$.

Study 2

A hallmark of hypodescent is that minority ancestry takes precedence even when it is less than 50% (i.e., "one drop" Black ancestry makes a person Black). We examined whether less than 50% distinctive-dangerous liquid could "convert" relatively ordinary-benign liquids.

Method

Participants. We repeated the sample size of Study 1; thus, we recruited approximately 100 participants on Amazon Mechanical Turk to reach 50 participants per question. Sample size was derived using the same logic as in Study 1. The final sample consisted of 93 participants (54 women, 39 men). Three participants were excluded from data analysis for vague or missing answers on at least one trial.

Design and procedure. The overall design of Study 2 was a transformation-like procedure (Keil, 1992; Rips, 1989) examining whether distinctive-dangerous liquids could "convert" ordinary-benign liquids (and vice versa). This also allowed us to examine whether participants believed that less than 50% of a distinctive-dangerous liquid was sufficient to convert a liquid, consistent with "one-drop-rule"-like thinking. We used the same liquid pairs as in Study 1.

Participants read short descriptions of liquid mixtures and were prompted to input a number into an open-ended text box. An example of these descriptions is as follows:

> A person has a jug containing 128 ounces of apple juice (1 gallon). If she added urine to the jug would the liquid be apple juice or urine? How many ounces of urine does she need to add before the liquid is urine? Please indicate amount below.

This approach allowed people to submit any possible answer, including rejecting that such conversion was possible. Participants received only four of the total of eight possible conversions. Specifically, participants received each pair in only one direction; for example, participants would receive either cranberry juice to vodka or vodka to cranberry juice.

Data analysis. Because participants could input any numerical amount, the variance of the sample was too large and nonnormal for a linear model on the raw data (answers included extremes such as one millionth of an ounce and one million ounces). To account for this problem, we used two data analysis methods.

The first data analysis strategy was a logistic regression. We coded the raw data into two categories that captured the direction of the asymmetry: Participants received a 0 when they provided a number that exceeded the original quantity, implying that the mixture had to contain at least 51% of the new liquid to convert, and a 1 when they provided a number equal to or less than the original quantity, implying that the mixture had to contain 50% or less of the new liquid to convert.

We also tested for the presence of an asymmetry using a linear model on transformed data. We transformed the data using two steps. First, we divided all participant entries by the starting liquid amount, which adjusts for the different starting quantities. Second, we took the log (base e) of these data to correct for the high variance and nonnormal distribution.

Results

Only 11 participants rejected the idea that a conversion was possible outright; of these, 7 occurred only in the high-to-low distinctive direction (e.g., cyanide to water), whereas the other 4 occurred across the board. Thus, the majority of participants (88%) produced a numerical answer across all conversions, $\chi^2(1, N = 90) = 49.89$, $p < .001$.

We hypothesized that participants would asymmetrically categorize liquid mixtures, such that distinctive-dangerous liquids could convert benign-ordinary liquids more easily than vice versa. To test this prediction, we first examined categorical data (0 = added amount exceeds the starting amount; 1 = added amount is equal to or less than the starting amount) using a multilevel logistic regression with distinctiveness (high vs. low) as a fixed effect and participant and trial as random effects. This analysis revealed the predicted asymmetry, $b = 4.00$, $SE = 0.69$, $p < .001$, odds ratio (OR) = 54.76. Participants reported that it would require relatively small amounts of a distinctive-dangerous liquid to convert an ordinary-benign liquid. Thus, 89.74% of participants reported that it would take 50% or less added cyanide (for example) to convert water to cyanide, 95% CI = [74.84%, 96.66%]. In the opposite direction, however, only 25.00% of participants reported 50% or less water (for example) could convert cyanide to water, 95% CI = [13.24%, 41.52%]. Rather, the majority of participants said that it would require a great deal of an ordinary-benign liquid (such as water) to convert a distinctive-dangerous liquid (such as cyanide).

Next, we retested the same hypothesis using a linear model to ensure that the results were reproducible across different statistical approaches. We employed a multilevel linear model. The outcome variable was the log of how much added liquid (proportional to the starting amount) participants stated would be required to convert the starting liquid. Distinctiveness-dangerousness (high vs. low) was a fixed effect, and participant and trial were random effects. This analysis again confirmed our hypothesis, $b = 1.90$, $SE = 0.267$, $p < .001$, $\beta = 0.61$. Converting from ordinary-benign to dangerous-distinctive required very little: If one had 100 ounces of an ordinary-benign liquid (e.g., water), adding a median of 1 ounce of dangerous-distinctive liquid (e.g., cyanide) would convert it. However, larger amounts of ordinary-benign liquid were judged as required to convert dangerous-distinctive liquids. For example, if one had 100 ounces of a dangerous-distinctive liquid (e.g., cyanide), it required adding a median of 300 ounces of ordinary-benign liquid (e.g., water) to convert it.

We again examined whether there were item differences. To test this, we employed a 2 (liquid: distinctive-dangerous, ordinary-benign) by 4 (item: vodka-cranberry juice, Vicodin-saline, urine-apple juice, water-cyanide) two-way ANOVA on the log proportion of liquid necessary to convert one liquid into another. There was again a main effect of distinctiveness-dangerousness, $F(1, 294) = 43.54$,

Table 2. Asymmetric Conversions of Liquids (Study 2)

Liquid conversion (1 to 2)	Starting amount of Liquid 1	Amount of Liquid 2 needed to convert Liquid 1 into Liquid 2	Percentage of mixture that Liquid 2 makes up
Cranberry juice to vodka	8 oz.	8 oz.	50
Vodka to cranberry juice	8 oz.	18 oz.	69
Saline to Vicodin	50 oz.	3.67 oz.	7
Vicodin to saline	50 oz.	273.47 oz.	85
Apple juice to urine	128 oz.	51.2 oz.	29
Urine to apple juice	128 oz.	130.56 oz.	50
Water to cyanide	100 oz.	1 oz.	1
Cyanide to water	100 oz.	300 oz.	75

Note: This table depicts how much of Liquid 2 one needs to add to convert a starting Liquid 1 into Liquid 2. To illustrate (cranberry juice to vodka), people read about a cup containing 8 ounces of cranberry juice. On average, participants said that adding 8 ounces of vodka to the cranberry juice would result in vodka. Put another way, they believed a liquid mixture containing 50% vodka and 50% cranberry juice would count as vodka.

p < .001, which was further qualified by a two-way interaction between distinctiveness-dangerousness and item, $F(3, 294) = 3.16$, $p = .025$, demonstrating that the asymmetry was stronger for some items than for others (Table 2).

Study 3

Having documented the existence of hypodescent-like effects for liquids, we sought a direct test of the conceptual-prominence account. Thus, the aim of Study 3 was to test whether the asymmetric categorization of liquid mixtures was predicted by relative differences in the distinctiveness and dangerousness of the component liquids.

Method

Participants. We recruited 126 participants from Amazon Mechanical Turk. Sample size was derived using the same logic as in Studies 1 and 2 (n = 50 per condition, N = 100). Given the length of the survey (84 two-part questions), we slightly overrecruited to correct for potentially noisier data. Participants were divided equally between two samples (Sample 1: dangerousness, distinctiveness, potency measures; Sample 2: categorization measures).

Design and procedure. The overall design of Study 3 was to test whether asymmetries in how liquid mixtures are categorized (direction and magnitude) are predicted by how relatively dangerous and distinctive participants view the component liquids to be. All 28 possible pairs of the 8 liquids used in Studies 1 and 2 were used. This method confirmed that the documented effect generalized across a variety of liquid mixtures rather than ones that we handpicked. The only replacement was that we switched Vicodin with morphine to avoid a brand name.

Data collection occurred with two separate samples of participants. The first sample answered questions about the relative dangerousness, distinctiveness, and potency of each liquid. The potency measure was included to measure how causally powerful participants believed each type of liquid was.

For each dimension, participants completed a two-part scale. First, they were asked which liquid was more dangerous, distinctive, or potent. Second, they were asked how much more dangerous, distinctive, or potent their selection was on a 5-point scale ranging from *a tiny bit more* to *a great deal more*. This two-part scale produced a score ranging from −5 to 5 that measured the direction and magnitude of the relative dangerousness, distinctiveness, and potency of each liquid pair. Note that participants in this sample were asked to directly compare the liquids, and there was never any mention of mixtures or categorization.

The second sample read brief descriptions of liquid mixtures (e.g., "Someone mixed together cyanide and water in equal parts"). Participants then evaluated the veracity of two statements. For example, for water-cyanide, they were asked to evaluate the statements "This liquid is cyanide" and "This liquid is water" on 6-point scales ranging from *definitely true* to *definitely false*. These scales were converted into a −5 to 5 difference score measuring the direction and magnitude of the asymmetric categorization.

We used this two-part between-subjects procedure in order to prevent task demands and spillover effects. This provided a far stronger test of our hypotheses than a within-subjects design. Because of this methodological decision, we analyzed data at the item level using the sample of 28 item means.

Results

The three measures (dangerousness, distinctiveness, and potency) were strongly correlated, *r*s(26) = .94–.98, *p*s < .001. This meant it was unfeasible to examine a combined model (because of multicollinearity). Instead, to test the hypothesis that higher asymmetries in dangerousness and distinctiveness predict higher asymmetries in categorization, we used three separate linear models. A linear model with a composite of the three measures produced qualitatively similar results. As predicted, there was a large effect of dangerousness, b = 0.24, SE = 0.04, p < .001, β = 0.76, and distinctiveness, b = 0.32, SE = 0.04, p < .001, β = 0.87. There was also an effect of potency, b = 0.25, SE = 0.03, p < .001, β = 0.84. Each of these measures captured a considerable portion of the variance—dangerousness: 57%, distinctiveness: 75%, and potency: 71%.

To visualize these results (Fig. 1), we calculated the average distinctiveness, danger, and potency for each liquid. This allowed us to create an ordering of the pairs from lowest distinctiveness-dangerousness (water) to highest distinctiveness-dangerousness (cyanide). By repeating this order on the *x*- and *y*-axes (similar to a correlation matrix), we were able to plot all possible pairs and how they were categorized. As Figure 1 shows, 26 out of 28 pairs (93%) were correctly predicted, such that the pair was categorized more as the distinctive-dangerous component, $\chi^2(1, N = 28) = 18.9$, p < .001. Also, Figure 1 visually corroborates that the magnitude of the asymmetry was highest for the pairs with the largest gap in distinctiveness-dangerousness (e.g., water-cyanide) than for approximately equally distinctive-dangerous pairs (e.g., apple juice-cranberry juice). This is revealed by the greater asymmetry (darker red color) on the corner poles of the grid.

Study 4

The aim of Study 4 was to examine whether the same predictors (i.e., distinctiveness and dangerousness) explain asymmetries in racial categorization as explain asymmetries in liquid categorization. We employed analogous methods to those in Study 3 to maximize comparability.

Method

Participants. Past work on hypodescent has found smaller effect sizes than we found for liquid measures in Study 3 and generally more variation depending on participant demographics (Ho et al., 2011). Therefore, to ensure comparable power and consensus across studies, we doubled our sample sizes from those used in Study 3. A total of 123 participants answered dangerousness-distinctiveness-potency measures (92 White, 11 Asian, 9 Black, 9 multiracial, and 2 other; 65 women, 58 men; mean age = 35.86 years); 120 participants answered categorization questions (89 White, 14 Asian, 9 Black, 1 Native American, and 7 multiracial; 69 women, 51 men; mean age = 35.64 years). Participants were recruited from Amazon Mechanical Turk.

Design and procedure. We used eight racial or ethnic groups: White, Black, East Asian, South Asian, Native American, Latino, Arab, and Aboriginal Australian. As in Study 3, we examined all 28 possible pairings of these groups.

One sample rated the racial pairs on dangerousness, distinctiveness, and potency (of the genetic ancestry itself). As before, the scales were two part. For example, for the dangerousness scale, participants were first asked, “Which of these racial-ethnic groups is more dangerous?” They were then asked, “How much more dangerous?” Participants responded on a 5-point Likert scale ranging from *a tiny bit more* to *a great deal more*, creating a 10-point scale for each pair. The distinctiveness and potency scales were analogous. For potency, however, we asked specifically about racial ancestry, to maximize the similarity to Study 3: “Which type of racial ancestry is more potent (dominant, strong)?”

A second sample categorized biracial individuals. Participants read, “There is a person whose ancestry is equal parts *X* and *Y*.” They were then prompted to evaluate the veracity of two statements: “This person’s race is *X*” and “This person’s race is *Y*,” on 6-point scales ranging from *definitely true* to *definitely false*. The difference score between these scales produced a measure of asymmetric categorization.

Results

In contrast to the liquid mixtures, the three measures were not correlated with each other. Although potency and dangerousness continued to be positively correlated, $r(26)$ = .91, p < .001, they were both negatively correlated with distinctiveness—potency: $r(26)$ = −.42, p = .026; dangerousness: $r(26)$ = −.50, p = .007. To test the critical hypothesis that dangerousness and distinctiveness predict asymmetric categorization, we employed a combined model with a danger-potency composite (to reduce collinearity) and distinctiveness as independent variables. The composite variable was a simple averaging of the two measures. The dependent variable

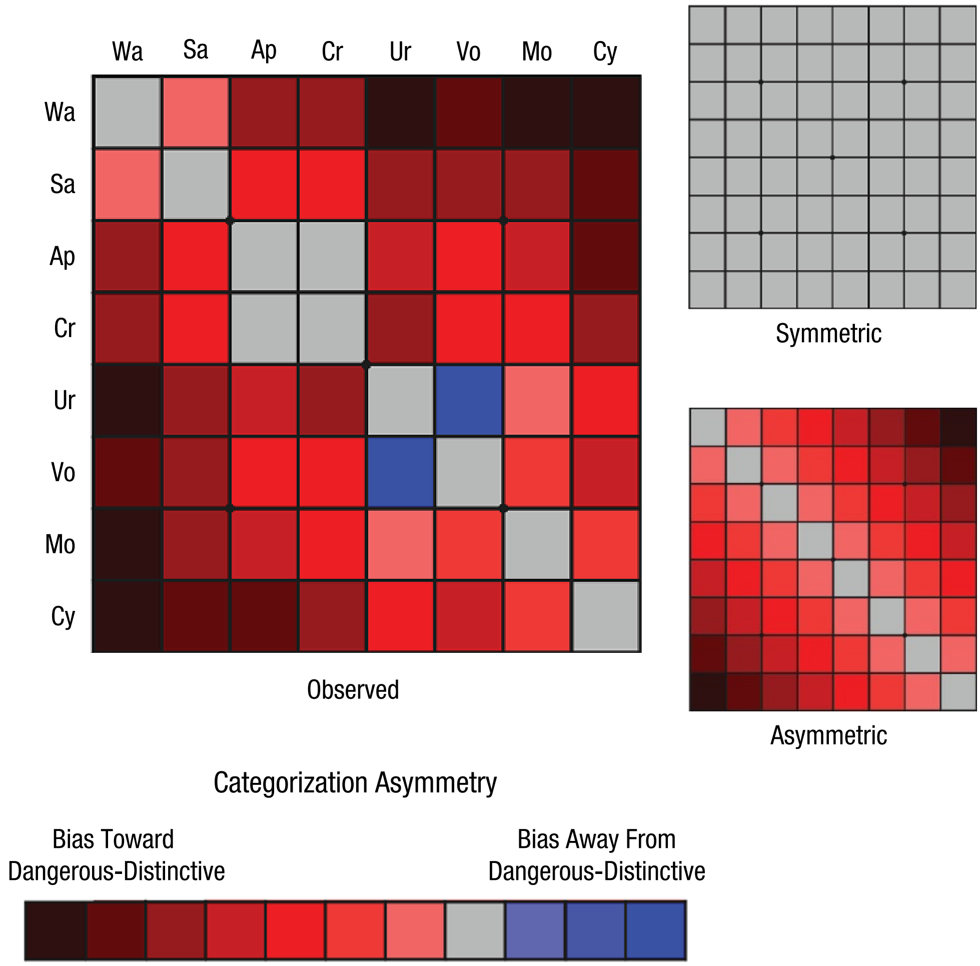

Fig. 1. The relationship of distinctiveness, danger, and potency to asymmetric categorization for liquid mixtures (Study 3). To visualize the results, we ordered individual liquids by how distinctive, dangerous, and potent they were. The liquids were (in order) water, saline, apple juice, cranberry juice, urine, vodka, morphine, and cyanide. We plotted each possible pair of liquid and how they were categorized. Specifically, we plotted how large the asymmetry was in the direction of the distinctive component (red = high, gray = none, blue = asymmetry in opposite direction). The null hypothesis, that there would be no asymmetry, would result in an all gray grid. The hypothesis that higher distinctive components dominate category judgments would result in the idealized bottom right grid.

was the difference score between the two categorization measures. As hypothesized, both danger-potency, $b = 0.15$, $SE = 0.03$, $p < .001$, $\beta = 0.77$, and distinctiveness, $b = 0.18$, $SE = 0.04$, $p < .001$, $\beta = 0.71$, independently predicted hypodescent (all linear models based on single variables revealed similar patterns). Together, these dimensions accounted for 57% of the variance in categorization.

There was asymmetric categorization for all of the Black-*X* biracial individuals: Black-White, Black-East Asian, Black-South Asian, Black-Native American, Black-Latino, Black-Arab, and Black-Aboriginal, all ps < .05, such that all biracial individuals with Black ancestry were categorized as more Black. There was also asymmetric categorization for all White-*X* biracial individuals: White-East Asian, White-South Asian, White-Latino, White-Arab, and White-Aboriginal, $p < .05$, and a marginal effect for White-Native American, $p = .086$, such that biracial individuals with White ancestry were categorized as less White. Finally, there was also asymmetric categorization for all of the remaining Arab-*X* pairings: Arab-East Asian, Arab-Native American, Arab-Latino, $p < .05$, and a marginal effect for Arab-South Asian, $p = .075$, such that all biracial individuals with Arab ancestry were categorized as more Arab. The other racial categories, East Asian, South Asian, Native American, Latino, and Australian Aboriginal, did not produce statistically significant asymmetric categorization when paired together (all hypodescent effects: $p > .10$).

General Discussion

We found support for our model. Primarily, hypodescent-like effects occurred in at least one nonsocial domain. The effects were in close correspondence: People categorized liquid mixtures asymmetrically, the relative distinctiveness-dangerousness of the components predicted the direction and magnitude of the asymmetry, and this asymmetry occurred even when the distinctive-dangerous component was less than 50% of the mixture. The similarity of this effect to racial hypodescent supports the proposal that general cognitive mechanisms can produce hypodescent (e.g., Halberstadt et al., 2011). We also identified hypodescent in a number of novel biracial cases. We found hypodescent in nonmajority cases (e.g., Black-Asian biracial individuals were categorized as Black). We also documented robust Arab hypodescent; most biracial individuals with Arab ancestry tended to be categorized as Arabs (consistent with the increasing perceived threat of Arabic individuals; Steele, Parker, & Lickel, 2015).

Our model has advantages over previous accounts. Attention theory proposes that attention shifts toward properties that distinguish relatively novel exemplars from exemplars seen earlier in learning. This account cannot easily explain the hypodescent differences among minority stimuli. For example, Black ancestry took precedence over Asian ancestry, despite the higher frequency of Black people in the U.S. population and media (American Community Survey, 2015; Smith et al., 2015). By being less frequent, Asian people would be encountered later, on average, by White Americans; thus, one plausible interpretation of attention theory is that learning history would incorrectly predict a stronger hypodescent effect for Asian ancestry. Extending the role of attention to include the prominence of dangerousness and distinctiveness addresses this limitation; our account correctly predicts the direction and magnitude of hypodescent among minority groups. Nevertheless, the relationship between these accounts is an empirical matter that could be answered by directly pitting learning history against dangerousness and distinctiveness.

As for motivational accounts based on racism, they do not readily predict liquid hypodescent-like effects (Ho et al., 2011). Instead, racism seems to work through domain-general processes. Motivational accounts based on domain-general negativity bias (Ho et al., 2015; Rozin & Royzman, 2011) are more compatible. However, many specific examples are not straightforwardly predicted by negativity bias; for example, cranberry-vodka and morphine-saline solutions were asymmetrically categorized as vodka and morphine, respectively. Vodka and morphine are neutral or desired components—far from contaminants. Their priority is better explained by prominence in attention because of their distinctive and potentially threatening (if not monitored) properties.

We believe that dangerous and distinctive properties are dissociable causes of selective attention. Given their high correlation in Study 3, one may wonder if they reflect the same psychological dimension. However, research on generics (Cimpian, Brandone, & Gelman, 2010), research on attention (Kruschke, 2003; LoBue, 2009; Öhman et al., 2001), and the results of Study 4 all suggest they are psychologically dissociable. Thus, we assume they are independent sources of conceptual prominence. On a related note, the different correlations in Studies 3 and 4 may raise concerns. However, these correlations were driven by the nature of the items we selected and not by the proposed mechanism. See the Supplemental Material available online for further discussion of these correlations. Nevertheless, their interrelations are independent of our predictions. Still, these points warrant empirical clarification.

One caveat to our account is that basic cognitive mechanisms could be overridden by cultural norms or ideological motives. Someone who abides by an ideology that multiracial people are an independent category ("multiracial"; Hickman, 1997) might not show hypodescent. Similarly, Black individuals sometimes have reasons to be inclusive of who is Black (see Davis, 1991; Morning, 2009; Roberts & Gelman, 2015), which suggests that Black participants' hypodescent is governed by different processes. Future research could explore whether conceptual prominence governs how Black participants categorize other biracial individuals. Nevertheless, this limitation is also true of other accounts (Roberts & Gelman, 2015).

We propose that hypodescent-like effects may emerge across many domains. Nevertheless, the causal structure of the domain imposes constraints. Hypodescent requires that mixtures assimilate into preexisting categories; however, one can conceptualize mixtures as distinct entities (e.g., ligers and sporks). If mixtures are unusual within a domain, they may be conceptualized as a novel entity. Furthermore, hypodescent requires that underlying causal components (ancestry, chemical makeup) are central to category judgments; otherwise their relative prominence is irrelevant (e.g., artifact concepts are less influenced by structure; Bloom, 1996). This might explain why children do not express racial hypodescent, because they do not understand that race is ancestry based (Roberts & Gelman, 2015).

In conclusion, we provide evidence that hypodescent is based in the conceptual prominence of dangerous and distinctive components. Selective attention to dangerous and distinctive features causes them to be more prominent in conceptual representation; in turn, mixtures are seen as better members of the category that explains these features. Our model is an extension of the attentional account (Halberstadt et al., 2011), building on how selective attention combines with conceptual factors to produce asymmetric categorization. Our model is potentially compatible with motivational accounts based on racism when racism is viewed as an indirect cause of perceived danger and distinctiveness; the primary difference is the role of basic, cognitive mechanisms rather than social-cognitive factors in explaining hypodescent. Supporting our account's generativity, we found hypodescent-like effects in novel contexts, including liquids and biracial cases not examined previously. We hope this evidence and theoretical groundwork will advance the study of hypodescent and its cognitive foundations.

Action Editor

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Author Contributions

A. Noyes developed the idea for the study, implemented the design, analyzed the data, and wrote the first draft of the manuscript. F. C. Keil provided critical revisions.

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The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Open Practices

All data and materials have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/qtb5u/. The design and analysis plans for these studies were not preregistered. The complete Open Practices Disclosure for this article can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797617753562. This article has received badges for Open Data and Open Materials. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

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