American Psychological Association

Journal of Educational Psychology

0022-0663/19/$12.00

http://dx.doi.org/10.1037/edu0000366

Maybe They're Born With It, or Maybe It's Experience: Toward a Deeper Understanding of the Learning Style Myth

Shaylene E. Nancekivell, Priti Shah, and Susan A. Gelman
University of Michigan

Decades of research suggest that learning styles, or the belief that people learn better when they receive instruction in their dominant way of learning, may be one of the most pervasive myths about cognition. Nonetheless, little is known about what it means to believe in learning styles. The present investigation uses one theoretical framework—psychological essentialism—to explore the content and consistency of people's learning style beliefs. Psychological essentialism is a belief that certain categories (such as dogs, girls, or visual learners) have an underlying reality or true nature that is biologically based and highly predictive of many other features (Gelman, 2003). We tested the prevalence of erroneous essentialist beliefs regarding learning styles in both educators and noneducators, including that learning styles are innate, unchanging, discrete, and wired into the brain. In each of two experiments, we identified two groups of learning style believers, with one group holding an essentialist interpretation of learning styles, and the other group holding a nonessentialist interpretation of learning styles. No differences were found between educators' and noneducators' beliefs. In fact, only one factor was found to be a significant predictor of learning style beliefs for educators: the age of the population with whom they work. Specifically, those who worked with younger children were more likely to interpret learning styles in an essentialist way. Together the findings demonstrate that learning style beliefs are far more complex and variable than previously recognized.

Educational Impact and Implications Statement

The learning style myth posits that students learn better when the mode of instruction is tailored to their visual, auditory, or kinesthetic learning style. In two studies, we examined educators' and noneducators' beliefs about what it means to have a learning style. Do people believe that learning styles are present at birth, uninfluenced by experience, affect brain function, or predict life outcomes? The findings reveal systematic differences in how people reason about learning styles. Some people are more likely than others to view learning styles as a trait that students inherit from their parents and that affects their brain function. We also found that educators who work with younger children are more likely to hold this essentialist view of learning styles than others. These findings are relevant for those hoping to better understand the psychological basis of neuroeducational myths.

Keywords: essentialism, learning styles, educational beliefs, neuromyths

The learning style myth posits that people learn better when they receive instruction that matches their dominant way of learning (e.g., Pashler, McDaniel, Rohrer, & Bjork, 2008), such as visual, auditory, or kinesthetic ways of learning (Coffield, Moseley, Hall, & Ecclestone, 2004). Learning style philosophies are considered a myth because they provide anywhere from inadequate to incorrect portrayals of learning (Dembo & Howard, 2007; Pashler et al., 2008; Scott, 2010). To date, there has been no evidence that matching or meshing instruction to someone's self-reported learning style positively affects their ability to learn new information (e.g., Husmann & O'Loughlin, 2018; Knoll, Otani, Skeel, & Van Horn, 2017; Krätzig & Arbuthnott, 2006; Rogowsky, Calhoun, & Tallal, 2015; also see Pashler et al., 2008 for a review).

Persisting for decades, the learning style myth is thought to be one of the most pervasive misconceptions about cognition (Coffield et al., 2004; Kirschner & van Merriënboer, 2013; Sharp, Bowker, & Byrne, 2008). Surveys conducted in in the United States, Turkey, Portugal, China, Switzerland, the United Kingdom, and Latin America suggest that average rates of learning style myth endorsement among the general public and educators in Western and industrialized countries (Henrich, Heine, & Norenzayan, 2010) range from 80–95% (Coffield et al., 2004; Dekker, Lee, Howard-Jones, & Jolles, 2012; Dündar & Gündüz, 2016; Gleichgerrcht, Lira Luttges, Salvarezza, & Campos, 2015; Morehead, Rhodes, & Delozier, 2016; Pei, Howard-Jones, Zhang, Liu, & Jin, 2015; Rato, Abreu, & Castro-Caldas, 2013; Scott, 2010;

Shaylene E. Nancekivell, Priti Shah, and Susan A. Gelman, Department of Psychology, University of Michigan.

Correspondence concerning this article should be addressed to Shaylene E. Nancekivell, Department of Psychology, University of Michigan, 530 Church Street, Ann Arbor, MI 48109-1043. E-mail: snancek@umich.edu

Tardif, Doudin, & Meylan, 2015). Google Trends shows that searches for information about learning styles are common in non–educators in Western and industrialized countries countries as well, including Jamaica, the Philippines, Trinidad and Tobago, and South Africa (Google Public Data, 2018).

Belief in learning styles has consequences. Teachers and instructors spend time and effort matching lessons to students' perceived learning styles (Newton & Miah, 2017; Scott, 2010; Tardif et al., 2015), even though usually all students would benefit from receiving information in multiple ways (e.g., Lapp, Flood, & Fisher, 1999; Mayer, 2002; Moreno & Mayer, 1999). Students choose to study in ways that match their perceived learning style and incorrectly believe it will help them learn better (Husmann et al., 2018; Massa & Mayer, 2006; Morehead et al., 2016). Some teacher certification programs incorporate learning styles into training courses, wasting valuable time and resources (Lethaby & Harries, 2015; Tardif et al., 2015). Academic support centers at higher-education institutions provide services based on students' styles (McCabe, 2018)—despite the lack of evidence that assessing learning styles provides any added benefit in these services. Moreover, it is not unheard of to find peer-reviewed research incorporating learning style interventions into their studies without first confirming the assumptions of the theory underlying their research (e.g., Lujan & DiCarlo, 2006; Pyryt, Sandals, & Begoray, 1998; also see Newton, 2015 for a review). Industry has capitalized on this desire to use learning style philosophies in the classroom (Coffield et al., 2004; Scott, 2010), resulting in widely available and commonly used assessments such as the Dunn, Dunn, and Price Learning Styles Inventory (Coffield et al., 2004; see http://www.learningstyles.net/).

Given the impact of the learning style myth on education, understanding its nature has the potential to improve educational practices around the world. However, to date, little is known about what people think it means to have a learning style. Prior studies of learning styles have been primarily limited to identifying who endorses them, examining when they are used in the classroom, and documenting how they conflict with the scientific evidence (e.g., Coffield et al., 2004; Dekker et al., 2012; Newton et al., 2017; Pashler et al., 2008; Tardif et al., 2015). Such studies have mainly focused on assessing whether participants believe that learning styles exist (via simple yes/no questions) but does not examine the content of those beliefs. Although past work has been instrumental in demonstrating the widespread acceptance of learning styles, it leaves many questions unanswered. For example, we are unaware of any research examining whether people believe that learning styles mark distinct kinds of people, are stable over time, or predict different life outcomes. Moreover, even though learning styles are categorized as a neuroscience-based myth, no prior work, to our knowledge, has investigated whether or how people believe learning styles are instantiated in the brain. In short, knowing that someone endorses learning styles tells us little if anything about the nature of the beliefs that make up the concept. Of key importance to ultimately debunking the learning style myth will be fully understanding the form and function of people's beliefs.

The current investigation uses one theoretical framework to explore people's beliefs about learning styles—psychological essentialism. Psychological essentialism is a belief that certain categories (such as dogs, girls, or auditory learners) have an underlying reality or true nature that one cannot observe directly but that is biologically based and highly predictive of many other features. In other words, according to essentialism, such categories are real, in several senses: they are discovered (vs. invented), they are natural (vs. artificial), they predict other properties, and they point to natural discontinuities in the world—an inborn, immutable biological reality (Gelman, 2003; Haslam, Rothschild, & Ernst, 2000; Medin & Ortony, 1989). For example, an essentialist view of the aggressiveness of pit bulls might include the belief that no matter how a pit bull is raised, aggression is wired into its brain and genetics. People display essentialist beliefs about a broad range of human kinds and intellectual abilities (e.g., Haslam et al., 2000; Rhodes & Mandalaywala, 2017; Thomas & Sarnecka, 2015). For example, most adults believe that one's intellectual capacity is determined at birth and cannot be substantially changed by experience (Gelman, Heyman, & Legare, 2007; Thomas et al., 2015).

An essentialist interpretation of learning styles would lead people to erroneously believe that learning styles emerge early in childhood, have a biological or genetic basis, are instantiated in the brain, mark distinct kinds of learners, predict learning outcomes, and are not open to change. Such assumptions about learning could be problematic because they would suggest that what people can learn is limited by their learning style and thus place artificial constraints on a learner's potential. Alternatively, people with a nonessentialist interpretation of learning styles may hold a looser conception in which learning styles are overlapping, nondiscrete preferences that are informed by experience and may change with context and over time. Under this nonessentialist interpretation, people's beliefs about learning styles may not be derived from any strong assumptions about how people learn or how their brains function. For example, visual learning styles may simply be a way for people to explain why some people are so skilled at remembering visual information—without requiring them to be specific about underlying mechanisms or even to think about these differences very deeply. A final possibility is that people may hold hybrid beliefs. Under this view, people may hold less consistent beliefs about learning styles and agree with some essentialist beliefs but not others. For example, some people may believe both that learning styles are inherited from one's parents and also that they are not instantiated in the brain.

The proposal that people may hold an essentialist view of learning styles is consistent with the small amount of prior work on learning style beliefs. It is consistent with theoretical work suggesting that the intuitive appeal of learning style philosophies may rest in their fit with people's preference for brain-based accounts of behavior and their desire to categorize people into types (Pashler et al., 2008; Pasquinelli, 2012).

It is also consistent with the only empirical study, to our knowledge, on essentialism and learning styles. Specifically, an unpublished dissertation found that the strength of people's belief in learning styles is linked to their belief that learning styles have a fatalistic genetic essence (Cheung, 2016; also discussed in Heine, Dar-Nimrod, Cheung, & Proulx, 2017). In this study, one group of participants ($N = 500$) completed three tasks: a decision-making task and two questionnaires. The decision-making task asked participants to judge what kind of teacher would be best for a particular kind of learner, whereas the questionnaires asked participants about the specific causes of learning styles (e.g., whether

it is all due to genetics or it is all due to the environment) and their beliefs about learning styles more generally (e.g., whether everyone can be categorized into a particular learning style). The researcher discovered that those reporting that learning styles have a genetic basis were more likely to believe that matching instruction to a student's learning style is an effective instructional method and that learning styles cannot be changed through experience (Cheung, 2016). Notably, the nature of these correlations also suggested that there may be substantial individual variability in people's beliefs (Cheung, 2016). Although this work is important and informative, it does not address whether people hold a range of essentialist beliefs about learning styles or whether they simply hold beliefs about their genetic instantiation. For example, these findings to do not speak to people's beliefs about the brain basis of learning styles, whether learning styles predict life outcomes, or whether people can have multiple styles. Moreover, this study also included both believers and nonbelievers, so it was unable to characterize the variability that might exist among endorsers of the myth, which is a core interest of the present investigation.

The Present Studies

The present studies focus on people's beliefs about one of the most common frameworks regarding learning styles, namely that there are three key learning styles corresponding to three learning modalities: auditory, visual, and kinesthetic (e.g., Dekker et al., 2012; Pashler et al., 2008; Sharp et al., 2008). Specifically, our investigation focuses on versions of learning styles most commonly assumed in the neuromyth literature, according to which, individuals learn better when they receive instruction in their preferred learning style (e.g., auditory, visual, kinesthetic) (see Dekker et al., 2012). This version is akin to the meshing versions of the myth, which focused on beliefs regarding how matching instruction to one's learning style affects learning outcomes (Dekker et al., 2012; Pashler et al., 2008; Sharp et al., 2008). There are certainly numerous other ways as well that people have characterized different types of thinking (e.g., thinking styles, cognitive styles, or cognitive preferences; Grigorenko & Sternberg, 1997; Kozhevnikov, Hegarty, & Mayer, 2002; Zhang & Sternberg, 2000). For example, the work by Zhang and Sternberg (2000) describes cognitive styles in terms of preferences for ways of thinking that are creative or legislative and analytical or judicial. These alternatives are not thought to be directly related to learning or learning outcomes but rather related to dispositions or preferences. They thus are not the focus of our research.

The goal of the present investigation is to test whether people's beliefs about learning styles are better characterized by an essentialist interpretation, a looser nonessentialist interpretation, or a hybrid interpretation. In two experiments, people's beliefs about learning styles were measured using an essentialism questionnaire. Based on prior work (Gelman et al., 2007; Haslam et al., 2000; Thomas et al., 2015), this questionnaire probed people's beliefs about seven key essentialist dimensions mentioned above: heritability, innateness, early emergence, immutability, inductive potential, biological instantiation, and constancy over time. Only those who believed in learning styles were included in our study.

Experiment 1

Method

Participants. Participants included 393 adults (M_{age} = 34.00 years) who were paid $1.00 each to complete a survey. The survey was distributed through Amazon Mechanical Turk to the general population of U.S. workers with a hit rate above 90%. Sixty-two adults were excluded from our final sample based on their lack of belief in learning styles or responses to control items (see exclusion section below for full breakdown). An additional eight people were tested but excluded because their GPS coordinates indicated that they were not from the United States.

The final sample included 331 adults (M_{age} = 34.35 years), all of whom reported believing in learning styles and passed the controls. The demographics of this sample were as follows: 99% spoke English as a first language, 55% were male, 75% attended college/university, and 6.5% worked in the education industry.

Procedure. Participants completed a 26-item survey that included one baseline belief question, 15 items probing essentialist beliefs, five control items, and five demographic questions. Before the survey began, all participants read the visual, auditory, kinesthetic learning style philosophy, explained as follows:

> Some people report that they have a learning style or one superior way of learning information. For example, some people report that they learn best through looking such as when looking at charts or diagrams; other people report that they learn best through listening such as when listening to a teacher or podcast; and other people report that they learn best through doing such as when creating chemical models or solving wooden puzzles.

This introductory explanation was included to ensure that all participants were considering the same learning style philosophy while answering the survey. The baseline question always appeared first and asked participants whether they believe that people have learning styles (see *Exclusions*, below). The 25 remaining items were divided into two blocks: Block 1 included all essentialism and control items, and Block 2 included demographic questions. Block order was fixed; however, item order was randomized within each block.

Essentialism items. The essentialism items asked participants to rate their agreement or disagreement with 15 statements about learning styles on a 6-point scale (*strongly disagree*, *disagree*, *somewhat disagree*, *somewhat agree*, *agree*, *strongly agree*). Items were designed to measure multiple aspects of essentialism (see Table 1 for item text). As indicated earlier, they were modeled closely after surveys used in prior investigations of essentialism (see Gelman et al., 2007; Thomas et al., 2015). The scale did not include a neutral midpoint because we wanted to be able to cleanly measure whether the participants endorsed or rejected each essentialist idea.

Items were formatted as follows:

People are born with a predisposition to have a certain learning style.

Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
o	o	o	o	o	o

Control items. Control items were included to ensure that participants were attending to the survey. They were structured

Table 1
Experiments 1 and 2: Labels and Wording for Essentialism Items

Item label	Item wording
Predisposed at birth	People are born with a predisposition to have a certain learning style.
Determined at birth	It is determined at birth how people learn best (e.g., their learning style). [A person's learning style is determined at birth.]
Detectable as child	How a very young child (e.g., preschooler) learns best is determined by their learning style.
Can change (RE)	People can change how they learn best (e.g., their learning style). [People can change their learning style.]
Experience (RE)	A person's experiences affect how they learn best (e.g., their learning style). [A person's experiences affect their learning style.]
Continuity	How a person learns best (e.g., their learning style) continues to be the same as they age. [A person's learning style continues to be the same as he/she ages.]
Brain	There are consistent differences between the brains of people who learn in different ways (e.g., learning styles). [There are consistent differences between the brains of people with different learning styles.]
Genes	In the future, scientists will be able to determine how a person learns best (e.g., their learning style) by examining their genes. [In the future, scientists will be able to determine a person's learning style by examining their genes.]
Inherited	How a person learns best (e.g., their learning style) is inherited from his/her parents. [A person's learning style is inherited from his/her parents.]
Multiple styles (RE)	A person can have multiple learning styles.
Kinds of people	People with different learning styles are different kinds of people.
Academic subjects (RE)	A person can have different learning styles for different academic subjects (e.g., math or reading).
Predicts career	A person's learning style predicts the type of career at which they will excel.
Predicts school	A person's learning style is predictive of the kinds of school settings from which they will learn the most.
Predicts teacher	A person's learning style predicts the kinds of teachers from whom they learn best.

Note. RE = reverse-coded item. Where the wording of an item differed for versions 1 and 2, version 2 appears in brackets.

similarly to the essentialism items; however, they asked about participants' beliefs about the relation of learning styles to items unrelated to learning modality (i.e., one's heartbeat, health, food preferences) or directly asked participants to select an item on the scale (e.g., "Please select disagree").

Demographic questions. The demographic questions collected information about participants' first language, occupation, age, level of education (i.e., elementary, high school, university/college), and gender.

Survey versions. There were two survey versions administered. Version 1 ($n = 197$) sometimes asked participants about their beliefs about how people learn best, whereas Version 2 ($n = 196$) always directly used the phrase, learning styles. Both included the definition provided earlier. The second survey version was administered to ensure that participants were only considering learning styles while they were responding to items. Independent t tests revealed that there was no effect of survey version on participant responses to any of the essentialist items (p value range = .08–.98). As such, the data were collapsed over survey versions. Table 1 shows the essentialism item text for each survey version.

Exclusions. Because we were interested in characterizing the beliefs of those who endorse learning styles, our final data set excluded the 30 participants who indicated that they did not believe in learning styles ($n = 6$) or were not sure ($n = 24$) and one additional participant who did not answer all essentialism items. It also excluded participants who did not correctly answer the control items (see above), including 18 participants who *strongly agreed* to at least one of the three unrelated control items (e.g., strongly agreed that how a person learns best (e.g., their learning style) predicts their food preferences), 11 participants who failed to select the scale item they were told on the control attention checks (e.g., did not select disagree when told to), and two participants who failed to do either. *Strongly agreed* was chosen as our cutoff criterion for the unrelated control items. We viewed only strong agreement as indicating lack of attention because one essentialist principle is that different kinds of people may be alike in unexpected and nonobvious ways. Thus, we expected that some people may assume that learning style could be somewhat predictive of other seemingly unrelated features, such as food preferences. Together these criteria resulted in 62 exclusions and a final sample size of 331.

Results and Discussion

The analyses had two main goals: (a) to understand how people construe learning styles, including variation in participants' interpretations, and (b) to understand what may be responsible for any individual differences in learning style beliefs.

Construal of Learning Styles

First, to determine whether people hold essentialist beliefs about learning styles, we converted participants' responses on the essentialism questionnaire into numbers such that higher responses indicated stronger essentialist beliefs (i.e., strong agreement with essentialism was scored as a 6). To accomplish this, four items were reverse coded (e.g., *strongly agree* was converted to a 1 instead of a 6). Reverse-coded items are indicated in all tables with the letters RE. After the conversion of scale items to numbers, participants were given an overall essentialism score. This was calculated by averaging across the 15 essentialism items. The survey's internal consistency based on this score reached acceptable levels (Cronbach's alpha = .71).

Next, we calculated the means, SDs, and proportion agreement for each item. Proportion agreement was calculated by summing the number of somewhat agree, agree, and strongly agree responses across participants and then dividing by the total number of participants. (For reverse-coded items, this was instead the number of somewhat disagree, disagree, and strongly disagree

responses across participants, divided by the total number of participants.) Means were tested against the midpoint (3.5) using a series of one-sample *t* tests; proportions were tested against the midpoint (0.5) using binomial tests. Table 2 provides a summary of responses by item and significance.

Participants' responses varied greatly across items. The same patterns were obtained whether examining mean scores or proportions of individuals (see Table 2). Eight of the items were significantly above the midpoint, and seven were significantly below the midpoint. People generally *agreed* with the essentialist ideas that learning styles are predisposed at birth, are detectable in childhood, remain the same with age, are instantiated in the brain, mark distinct kinds of people, predict career outcomes, and predict the school settings and teachers that people learn best from. People generally *disagreed* with the essentialist ideas that learning styles are determined at birth, cannot change, are uninfluenced by experience, are inheritable, are consistent across different academic subjects, are detectable in the genes, and are mutually exclusive (i.e., that a person can have only one learning style).

One finding that may at first appear surprising is that, although participants generally agreed that learning styles were predisposed at birth, they disagreed that learning styles were determined at birth. However, this may be due to the fact that the term determined is stronger and suggests that no other experiential factors might play a role. In contrast, the term predisposed suggests a tendency rather than absolute determination and leaves open the possibility that experience may alter one's learning style.

Understanding Cariability in Interpretation

We next sought to understand the variability in our data. One possibility was that participants would generally share a similar interpretation of learning styles. However, another possibility was that participants would vary more systematically in their interpretation of learning styles. Based on individual differences previously reported in the essentialism literature, we predicted that there would likely be some participants who essentialized learning styles more than others (e.g., Gelman et al., 2007; Heine et al., 2017; Thomas et al., 2015). More specifically, we predicted that participants might group into essentializers and nonessentializers.

To explore the structure of our data, we used a k-means cluster analysis that included all essentialism items and a prediction of two clusters. K-means cluster analyses allow researchers to identify structure in their data by classifying participants into groups based on their responses to multiple survey questions without necessitating the researcher to make assumptions regarding the exact nature of those groups (Punj & Stewart, 1983). The cluster analysis successfully identified two groups of respondents in less than 10 iterations: an essentializer group and a nonessentializer group. The essentializer group contained 66% of our sample. Its mean of 3.71 sat significantly above the midpoint of 3.5 (one sample *t* test, $t[219] = 11.48$, $p < .001$). The nonessentializer group contained 34% of our sample. Its mean of 3.00 sat significantly below the midpoint (one sample *t* test, $t[111] = -13.45$, $p < .001$). Table 3 provides a summary of each group.

Table 2
Experiment 1 Summary by Essentialism Item

Item	Mean	*SD*	Proportion agree
Predisposed at birth	**3.76****	1.10	**.66****
Determined at birth	2.87**	1.17	.30**
Detectable as child	**4.47****	.95	**.87****
Can change (RE)	3.10**	1.08	.33**
Experience (RE)	2.57**	1.00	.14**
Continuity	**3.62***	1.02	**.57***
Brain	**4.02****	1.02	**.77****
Genes	3.32*	1.28	.45
Inheritable	3.03**	1.09	.39**
Multiple styles (RE)	2.20**	.86	.07**
Kinds of people	**3.87****	1.15	**.66****
Academic subjects (RE)	2.05**	.85	**.05****
Predicts career	**3.87****	1.14	**.68****
Predicts school	**4.68***	1.02	**.92****
Predicts teacher	**4.66****	1.06	**.90****
Average Score	3.47	.47	N/A

Note. RE = reverse-coded item. Items that are significantly above midpoint are bolded.
* Test against midpoint is significant at the .05 level (two tailed). ** Test against midpoint is significant at the .01 level (two tailed).

Group Characteristics

A multivariate analysis of variance was conducted to allow us to better characterize each group using the essentialism survey items as the dependent variables. The essentializers provided higher essentialist responses than the nonessentializers on all items except one. The essentializers, more strongly than the nonessentializers, reported that learning styles are predisposed at birth, determined at birth, remain the same with age, are detectable in children, are instantiated in the brain, are detectable in the genes, are heritable, cannot change, are mutually exclusive, are consistent across different academic subjects, mark distinct kinds of people, predict career outcomes, and predict the school settings and teachers that people learn best from. Only one belief did not significantly differ between the two groups: that learning styles are uninfluenced by experience.

Together these findings suggest that our sample contains two groups of respondents, who hold consistently different beliefs about learning styles. The results from the item analyses confirm this assumption, with the essentializers holding stronger essentialist beliefs about most items. The findings suggest that the nonessentializers appear to hold a looser conception of learning styles as varying with context and throughout life. Despite showing many differences, the essentializers and nonessentializers both agreed that learning styles are detectable in childhood and that learning styles predict the school settings and teachers from which people learn best. This latter finding is unsurprising, given that learning styles for both groups likely provide a way of reasoning about learning in school settings during childhood. Nonetheless, one surprising result was the degree to which the essentializers endorsed that one's learning style could be influenced by experience.

Individual Differences

An exploratory hierarchical binary logistic regression was next conducted to determine whether age, education, industry of occupation, gender, or any two-way interactions between these potential demographic factors predicted whether a participant was an

Table 3
Experiment 1 Summary by Essentialism Item and Group

Item	Essentializers (n = 219)	Nonessentializers (n = 112)	p value	Partial eta squared
Predisposed at birth	4.18 (.85)	2.93 (1.06)	**<.001**	.29
Determined at birth	3.35 (.99)	1.94 (.91)	**<.001**	.33
Detectable as child	4.54 (.89)	4.32 (1.04)	**.044**	.01
Can change (RE)	3.19 (1.09)	2.93 (1.04)	**.039**	.01
Experience (RE)	2.58 (1.00)	2.55 (1.00)	.790	.00
Continuity	3.90 (.91)	3.09 (1.01)	**<.001**	.15
Brain	4.32 (.83)	3.45 (1.11)	**<.001**	.16
Genes	3.87 (1.07)	2.24 (.93)	**<.001**	.36
Inheritable	3.42 (.92)	2.29 (1.01)	**<.001**	.24
Multiple styles (RE)	2.31 (.89)	1.99 (.77)	**.001**	.03
Kinds of people	4.08 (1.01)	3.23 (1.21)	**<.001**	.12
Academic subjects (RE)	2.12 (.81)	1.92 (.91)	**.043**	.01
Predicts career	4.25 (.96)	3.13 (1.09)	**<.001**	.22
Predicts school	4.80 (.88)	4.44 (1.23)	**.002**	.03
Predicts teacher	4.76 (.96)	4.46 (1.21)	**.015**	.02
Overall	3.71 (.27)	3.00 (.40)	**<.001**	.53

Note. RE = reverse-coded item. *SD* is in brackets. Analysis converged over eight iterations. Bolded p values highlight items that significantly differ between groups.

essentializer or nonessentializer. Step 1 of our regression included main effects and Step 2 the interaction variables. Information regarding three levels of education was collected (elementary, high school, university/college), two of which (elementary and high school) were collapsed because only one participant indicated having no more than an elementary education. Thus, education was coded such that participants with an education level above high school received a 1, and participants with an education level at high school or below received a 0. Gender was dummy coded such that women were coded a 1 and all else a 0. We could not examine potential interactions between occupation and education because 100% of participants in the education industry had a university/college education. Omnibus tests of model coefficients revealed that both models were nonsignificant, $\chi^2_{\text{model\_1}}$ (4) = 0.085, p = 1.00, $\chi^2_{\text{model\_2}}$ (5) = 5.45, p = .36. These findings suggest that the demographic factors we measured did not predict people's beliefs about learning styles.

Experiment 2

Experiment 1 demonstrated that some, but not all, people hold essentialist beliefs about learning styles. Experiment 2 sought to expand upon these findings in a few key ways. First, to examine whether experience working in a learning environment might influence beliefs about learning styles, we added a sample of educators. Prior work has found that educators endorse the learning style myth at similar rates to the general public (e.g., Dekker et al., 2012). However, it is unclear from such work whether educators interpret learning styles in the same ways as the general public and how their experiences in school settings might influence their beliefs.

To explore in more depth the biological aspect of essentialism, questions were added to our survey assessing people's beliefs about how learning styles are instantiated in the brain. The findings of Experiment 1 suggested that many people believe that learning styles are instantiated in the brain in some way. However, these findings do not speak to how people believe learning styles are represented in the brain. For example, from these findings it is unknown whether people believe that those with different learning styles have measurable brain differences. Moreover, the essentialism of learning styles should entail strong beliefs about how learning styles are embedded in our biology. Given that learning styles are characterized as a neuroscience-based myth (Dekker et al., 2012), we thought it was important to investigate people's beliefs about the neural basis of learning styles.

Contrary to an essentialist interpretation, most participants in Experiment 1 indicated that they view learning styles as influenced by experience. To clarify the degree to which participants view experience as influencing one's learning style, Experiment 2 includes a series of switched-at-birth vignettes in which people must weigh heritability information against rearing-experience when deciding someone's current learning style (see Gelman & Wellman, 1991; Solomon, Johnson, Zaitchik, & Carey, 1996; Taylor, Rhodes, & Gelman, 2009). For example, in one vignette participants were told about an adopted child whose biological parents have a visual learning style but whose adoptive parents have a kinesthetic learning style. They were then asked to rate the likelihood that the child has each learning style. Judging that the child would share the learning style of their biological parents (even when this conflicts with their adoptive parents' learning style) would be evidence of inheritance-based thinking.

Method

Participants. Participants were recruited using Amazon Mechanical Turk Prime. Participants included 383 adults (M_{age} = 39.27 years) who were paid $1.25 each to complete a survey. (Fourteen additional people were tested but excluded because their GPS coordinates indicated that they were not from the United States.) Because we were interested in how educators' beliefs might differ from noneducators' beliefs, we selectively recruited educators by limiting half of our hits to those who had previously indicated their job function was related to education and training in an Amazon screening questionnaire. To ensure that the samples of

noneducators and educators had a similar education level, we also limited all hits to workers who had at least a bachelor's level education. During the demographics segment of our survey we confirmed that educators still identified as such by asking them to select from a list of potential occupational categories. Job titles of our educator sample can be found in Table 4. The majority of our educator sample (60.3%) were teachers. The Other category included a range of job titles, including advisor, program coordinator, and admissions consultant.

Exclusions. As in Experiment 1, the vast majority of participants indicated they believed in learning styles, with 93.7% indicating they believed, 3.1% indicating they did not believe, and 3.1% indicating they were not sure. Notably, fewer educators (90.7%) than noneducators (95.9%) indicated they believed in learning styles ($\chi^2 = 8.68$, $p = .013$). However, as we were interested in characterizing the beliefs of those who believe in learning styles, only those participants who indicated they believed in learning styles remained in the final sample. Overall, we excluded the 24 participants who did not believe in learning styles. Using the same criteria as Experiment 1, we then excluded an additional 22 participants based on their responses to the control items and one additional participant for failing to answer all the survey items. The final sample included 337 adults (135 educators, $M_{age} = 39.01$ years) who believed in learning styles and passed the controls.

Procedure. Participants completed a four-block survey. Block 1 always occurred first and included essentialism items identical to Version 2 of the essentialism survey items from Experiment 1 (see Table 1). The order of Blocks 2 and 3 was counterbalanced. Block 2 included of a series of switched-at-birth vignettes that explored participants' beliefs about the inheritance of learning styles, and Block 3 probed participants' beliefs about how learning styles may be instantiated in the brain. Block 4 always occurred last and assessed participants' experiences with learning styles and demographic information.

Switched-at-birth vignettes. In this block, participants received a set of three vignettes that varied the learning style of a baby's biological and adoptive parents. The following is a sample vignette with scales:

> This a story is about baby Z. Baby Z's biological parents have a visual learning style. They both learn best through looking such as when they are looking at charts or diagrams.
>
> Shortly after baby Z was born, baby Z was adopted by loving parents. Unlike baby Z's biological parents, baby Z's adoptive parents have a kinesthetic learning style. They learn best through doing such as when creating chemical models or solving wooden puzzles.

Zee is now 10 years old. Rate how likely baby Z's learning style is.

Variables	Not at all likely				Very likely
Auditory	o	o	o	o	o
Visual	o	o	o	o	o
Kinesthetic	o	o	o	o	o

Participants were randomly assigned to receive one of two sets. In set one, participants saw vignettes with the following contrasts: Biological parents have visual learning styles versus adoptive parents have kinesthetic learning styles; biological parents have auditory learning styles versus adoptive parents have visual learning styles; and biological parents have kinesthetic learning styles versus adoptive parents have auditory learning styles. In set two, participants saw the following: biological parents have kinesthetic learning styles versus adoptive parents have visual learning styles; biological parents have visual learning styles versus adoptive parents have auditory learning styles; and biological parents have auditory learning styles versus adoptive parents have kinesthetic learning styles. After each vignette, participants were asked to rate the likelihood of the baby having one of the three main learning styles (auditory, visual, kinesthetic) on a 5-point Likert scale ranging from 1 (*not at all likely*) to 5 (*very likely*). To cancel out order effects, we counterbalanced which set of stories participants viewed and the order in which they were presented.

Brain instantiation items. This 6-item survey probed participants' beliefs about how learning styles are instantiated in the brain. Participants were told, "A group of neuroscientists are interested in understanding the brains of those with different learning styles." They were then asked to rate the likelihood of the scientists making a series of potential discoveries about the brain, using a 5-point Likert scale that ranged from *not at all likely* to *very likely*. The potential discoveries were presented in random order and were as follows (RE indicates reverse coded):

- Those with different learning styles use different brain regions to learn.
- The characteristics of a person's brain during early childhood are the largest determining factor of their learning style as an adult.
- A person's learning style is better predicted by their life experiences than their brain's characteristics. (RE)
- People who have different learning styles have measurable differences in certain brain regions (e.g., size, density, or blood flow).
- There are no substantial differences between the brains of those with different learning styles. (RE)
- Brain imaging can be used to identify a person's learning style.

Personal learning-style questions. Participants were asked three questions about learning styles, in random order: What percentage of the population do you believe has a dominant learning style? What do you believe is the most common learning style? and What is your dominant learning style? Questions about participants' personal experiences with learning styles were not our primary focus but were included to allow us to explore further potential individual differences in learning style beliefs.

Table 4
Experiment 2, Breakdown of Educator Sample by Job Title

Job title	%
Teacher	60.3
Teacher's aide	8.9
Postsecondary instructor	6.2
Counselor	3.4
Administrator (e.g., principal)	2.7
Librarian	2.8
Tutor	2.1
Corporate trainer	1.4
Preschool teacher	1.7
Other	10.5

Demographic questions. The demographic questions collected information about participants' first language, occupation, age, level of education, gender, and parental status. During this portion of the survey, we also asked participants about their experiences with learning materials: How knowledgeable do you consider yourself in the science of learning? and How often do you consume media (e.g., books, documentaries, professional digests) about the science of learning? Educators were additionally asked to state their job title, which population they worked with, how long they have worked in the education industry, and whether they have ever discussed learning styles with their students. A demographic breakdown of both our educator and noneducator samples can be seen in Table 5.

To examine demographic differences between our samples, we conducted a series of comparisons. Education level was treated as an ordinal variable as follows: 4 = doctorate or professional degree, 3 = 4-year degree, 2 = 2-year degree, 1 = less than 2 years. χ^2 tests revealed that there were significantly more females in our educator sample, $\chi^2(1) = 13.92$, $p < .001$, and an ordinal logistic regression found that our educator sample was more educated than our noneducator sample, $\chi^2(1) = 16.52$, $p < .001$. The differences found in education level were most likely due to the fact that most of our educators were required to hold professional degrees for their employment. No other comparisons were significant (χ^2 tests, ps $> .08$).

Results and Discussion

Similar to Experiment 1, the analyses had two main goals. We sought to: (a) understand how people construe learning styles, including the degree to which people vary in their interpretations of learning styles, and (b) identify factors responsible for any individual differences in learning style beliefs. To achieve the first goal, we included two additional sets of questions. One examined people's beliefs about the instantiation of learning styles in the brain and another examined people's behavior on a switched-at-birth (SWAB) task (another common essentialism measure). To achieve the second goal, we added additional demographic factors that might predict essentialist beliefs in learning styles. Most notably, we added a set of analyses comparing the beliefs of educators and noneducators. It is highly possible that because of educators' experience thinking about learning and working with students, their beliefs might differ from those of noneducators. On the other hand, it is also possible that because of how widespread and stable endorsement of learning styles is across countries and populations, experience may not substantially influence people's beliefs.

Table 5
Experiment 2 Demographics of the Final Educator and Noneducator Samples

Variables	Noneducators (%)	Educators (%)
English is first language	97.2	95.9
Highest level of education		
Some college	1.9	.7
2-year degree	.9	1.4
4-year degree	67.6	48.6
Professional degree	25.8	44.5
Doctorate	3.3	4.1
Gender		
Male	44.1	26.0
Female	55.4	73.3
Other	.5	.7
Parents	52.1	61.6
Discusses LS with students	N/A	68.5
Length of time in education (*Years*)	N/A	12.4
Population worked with		
Adults	N/A	3.4
Postsecondary	N/A	19.2
High school	N/A	13.7
Middle school	N/A	17.1
Elementary school	N/A	34.9
Preschool	N/A	5.5
Other	N/A	5.5

Construal of Learning Styles

To begin, essentialism items were scored identically as in Experiment 1 (Cronbach's alpha = .78). Table 6 shows a summary by essentialism item. The findings of Experiment 2 replicated the results of Experiment 1 with only one minor exception: The continuity item, which was significantly above the midpoint in Experiment 1, was found to be no different from the midpoint in Experiment 2. Overall, these findings confirm that people generally agree with the essentialist ideas that learning styles are predisposed at birth, are detectable in childhood, are instantiated in the brain, mark distinct kinds of people, predict career outcomes, and predict the school settings and teachers from which people learn best. They also confirm that people generally disagree with the essentialist ideas that learning styles are determined at birth, cannot change, are uninfluenced by experience, are inheritable, are consistent across different academic subjects, are detectable in the genes, and are mutually exclusive (i.e., that a person can have only one learning style).

Understanding Variability of Interpretation

We next investigated whether this sample also contained two clusters of believers: essentializers and nonessentializers. As in Experiment 1, we next conducted a k-means cluster analysis using all essentialism items and a prediction of two clusters. Similar to Experiment 1, the cluster analysis successfully identified two groups of respondents: essentializers and nonessentializers. The mean of the essentializers, 3.86, sat significantly above the midpoint (one-sample t test, $t[168] = 14.40$, $p < .001$). The mean of the nonessentializers, 3.06, sat significantly below the midpoint (one-sample t test, $t[167] = -16.86$, $p < .001$). However, unlike Experiment 1, respondents were evenly divided between the groups. Table 3 provides a summary by group.

Group Characteristics

A multivariate analysis of variance was conducted to allow us to better characterize each group, using the essentialism survey items as the dependent variables. Similar to Experiment 1, the essentializers consistently scored higher on all essentialism items than the nonessentializers. However, unlike Experiment 1, responses to all essentialism items significantly differed between the two groups (see Table 7).

Table 6
Experiment 2 Summary by Essentialism Item

Item	Mean	*SD*	Proportion agree
Predisposed at birth	**3.77****	1.19	**.66****
Determined at birth	3.04**	1.18	.36**
Detectable as child	**4.42****	.99	**.87****
Can change (RE)	3.01**	1.02	.30**
Experience (RE)	2.48**	.96	.12**
Continuity	3.46	1.08	.49
Brain	**4.11****	1.01	**.80****
Genes	3.20*	1.23	.44*
Inheritable	3.03**	1.11	.40**
Multiple styles (RE)	2.05**	.83	.05**
Kinds of people	**3.68***	1.23	**.62****
Academic subjects (RE)	2.01**	.84	.05**
Predicts career	**4.03****	1.06	**.75****
Predicts school	**4.82****	.94	**.93****
Predicts teacher	**4.77****	.93	**.93****
Overall	3.46	.52	N/A

Note. RE = reverse-coded item. Above midpoint items are bolded. * Test against midpoint is significant at the .05 level (two tailed). ** Test against midpoint is significant at the .01 level (two tailed).

The findings of Experiment 2 replicate those of Experiment 1. They confirm that there are essentializers and nonessentializers of learning styles with different sets of beliefs. For example, the essentializers were more likely than the nonessentializers to endorse that learning styles are predisposed and determined at birth, detectable as a young child, the same across age, instantiated in the brain and genes, and inheritable and that they mark distinct kinds of people. Similar to Experiment 1, despite finding differences between our groups of believers, both groups seem to agree that learning styles can be influenced by experience and that one can have multiple learning styles. These findings suggest that even those who applied an essentialist framework for reasoning about learning styles viewed them as somewhat malleable.

Individual Differences in Beliefs

We next investigated which factors measured in Block 4 of our survey might be related to essentialist thinking about learning styles. To do so, we used a series of exploratory analyses. Given the number of factors we measured that might be related to learning style beliefs, we split the analyses into four parts. The first three models examined the relation between basic demographic factors, the learning media and knowledge measures, and the personal beliefs measures. Because of the relatedness of these models, we corrected the *p* values to .013 (i.e., .05/4). The last model examined the relationship between educator-specific measures and learning style beliefs.

Basic Demographics

To begin, we conducted a hierarchical binary regression to determine whether our basic demographic factors of age, education, gender, occupation, parental status, or any two-way interactions predicted whether a participant was an essentializer or a nonessentializer. Education was inputted as an ordinal variable (see *Method* section for scoring). Gender was dummy coded such that females were given a score of 1 and all else a score of 0. Parental status was dummy coded such that yes was scored as 1 and no as 0. Step 1 included our main effects and Step 2 our interactions. Omnibus tests of model coefficients revealed that both models were nonsignificant, $\chi^2_{\text{model\_1}}$ (5) = 5.07, p = .41, $\chi^2_{\text{model\_2}}$ (10) = 12.77, p = .24. Similar to Experiment 1, these findings suggest that the basic demographic factors we measured did not predict people's beliefs about learning styles. Given the null findings and to reduce the number of comparisons, demographic factors were left out of subsequent analyses, with the exception of the occupational measure. This latter measure will be included in subsequent analyses (i.e., SWAB and brain belief analyses) because of our a priori prediction that educator beliefs may differ from those of the general public.

Table 7
Experiment 2 Summary by Item and Group. SD in Brackets

Item	Essentializers (n = 169)	Nonessentializers (n = 168)	p value	Partial eta squared
Predisposed at birth	4.54 (.76)	3.00 (1.04)	**<.001**	.42
Determined at birth	3.86 (.84)	2.20 (.84)	**<.001**	.50
Detectable as child	4.68 (.88)	4.14 (1.02)	**<.001**	.08
Can change (RE)	3.32 (1.00)	2.71 (.96)	**<.001**	.09
Experience (RE)	2.66 (1.02)	2.30 (.87)	**<.001**	.04
Continuity	3.94 (.97)	2.98 (.97)	**<.001**	.20
Brain	4.51 (.80)	3.71 (1.03)	**<.001**	.16
Genes	3.79 (1.09)	2.61 (1.06)	**<.001**	.23
Inheritable	3.54 (1.01)	2.52 (.95)	**<.001**	.22
Multiple styles (RE)	2.19 (.91)	1.90 (.72)	**<.001**	.03
Kinds of people	4.22 (1.04)	3.14 (1.18)	**.002**	.19
Academic subjects (RE)	2.14 (.87)	1.89 (.78)	**<.001**	.02
Predicts career	4.47 (.82)	3.58 (1.08)	**.005**	.18
Predicts school	4.98 (.94)	4.67 (.93)	**<.001**	.03
Predicts teacher	5.00 (.84)	4.54 (.95)	**.002**	.06
Overall	3.86 (.32)	3.06 (.34)	**<.001**	.59

Note. RE = reverse-coded item. Analysis converged over 10 iterations. Bolded *p* values highlight items that significantly differ between groups.

Learning Media and Knowledge

During the demographic block, we asked participants two additional questions: one about their experiences with learning media (How often do you consume media (e.g., books, documentaries, professional digests) about the science of learning?) and another about how much they believed they knew about learning (How knowledgeable do you consider yourself in the science of learning?). Next, we examined whether either of these questions was related to participants' beliefs about learning styles. Before analyses began, learning media consumption was scored as follows: *never* was scored as 1, *rarely* as 2, *sometimes* as 3, and *regularly* as 4. Perceived knowledge level was already rated on a 5-point scale from 1 (*not at all knowledgeable*) to 5 (*very knowledgeable*).

Similar to our analysis of the basic demographic factors, a binary logistic regression was conducted to examine the relation between these two measures and whether a participant was an essentializer or a nonessentializer. Omnibus tests of model coefficients revealed nonsignificant models: perceived knowledgeability, $\chi^2(1) = 3.80$, $p = .051$, experience with learning media, $\chi^2(1) = .37$, $p = .54$.

Personal Learning Style Beliefs

Next, we examined participants' responses to our personal learning style questions. Table 8 shows the breakdown of participants' responses for the noneducator and educator samples. Similar to the demographic analyses, we also examined whether any of the personal learning style belief questions predicted whether participants were an essentializer or a nonessentializer. We inputted what people believed was the most common learning style and their reported dominant learning style as categorical variables and their estimates of the percentage of the population with a dominant learning style as a continuous variable into a binary logistic regression. The model did not find fit, $\chi^2(8) = 11.90$, $p = .10$, suggesting that these factors were unrelated to participants' beliefs.

Educator-Specific Factors

Educators were asked a few additional questions. We next examined whether the educator-specific factors of the population they work with, length of employment in education, and discussion of learning styles in the classroom were related to learning style beliefs. To do so, we conducted a binary logistic regression with these factors inputted as predictors. To simplify interpretation of our population variable and to account for differences in sample size between age groups, we converted it to a continuous variable in which those who worked with older populations received a higher score. The scoring was as following: those working with preschool populations were scored as 1, elementary as 2, middle school as 3, high school as 4, and postsecondary as 5. The 12 educators who reported working with adults not attending school or an alternative population (i.e., other) were excluded from these analyses. The regression model was significant, $\chi^2(8) = 11.39$, $p = .01$, with student population as the only significant predictor of learning style beliefs ($\beta = .37$, $\chi^2 = 6.06$, $p = .014$, $M_{\text{essentializers}} = 2.77$, $M_{\text{nonessentializers}} = 3.36$). A follow-up regression including potential confounding demographic factors of gender and education level showed that these factors did not account for this finding (nonsignificant main effects, $p > .47$). Together these findings suggest that educators who work with younger children are more likely to be essentializers than educators who work with older children.

In sum, we found that beliefs about learning styles are highly similar across different populations. Similar to Experiment 1, many of the factors measured, including being an educator, did not predict beliefs about learning styles. However, for educators one factor was found to be a significant predictor of learning style beliefs: the age of the population with whom they work. Specifically, those who worked with younger children were more likely to interpret learning styles in an essentialist way.

Table 8
Experiment 2, Personal Learning Style Responses for Final Educator and Noneducator Samples

Variables	Noneducator	Educator
People believed to have a dominant learning style (avgerage reported) (%)	60	65
Most common learning style (in general) (%)		
Visual	48.0	56.2
Kinesthetic	42.0	36.3
Auditory	7.9	4.4
Other	1.9	2.9
Dominant learning style (participant) (%)		
Visual	55.0	54.8
Kinesthetic	34.7	24.7
Auditory	9.4	6.7
Other	1.0	1.4

Learning Styles and the Brain

As discussed earlier, essentialism of learning styles should entail the belief that they are embedded in our biology. We thus predicted that those who essentialize learning styles would endorse more (incorrect) beliefs about how learning styles are instantiated in the brain. We tested this hypothesis by analyzing the findings from the brain-belief questionnaire (see Table 9). First, participants were given a 5-point score for each item corresponding to their selection on the Likert scale and a brain belief score that was created by averaging across the six items. The brain belief score represented the degree to which they believed that learning styles were instantiated in the brain. We then conducted an ANOVA that included occupation (educator vs. noneducator) and group (essentializer or nonessentializer) as between-groups factors and brain belief score as the dependent variable. This revealed a main effect of group ($F[1, 333] = 53.27$, $p = .001$, $\eta^2; = .14$) but no effect of occupation status ($F[1, 337] = .024$, $p = .80$) or interaction ($F[1, 337] = .07$, $p = .78$). For simple effects analyses a Bonferroni-corrected p value of .008 was adopted (i.e., .05 divided by 6). Simple effects analyses revealed that the two groups answered differently on all items of the brain questionnaire (independent samples t tests, ps $< .008$). Table 9 provides a summary of participants' responses to each item on the survey as a function of group, including the results of a series of tests against the midpoint of 3.

Overall, the essentializers were more likely than the nonessentializers to endorse that people with different learning styles have substantial brain differences that are measurable and detectable

Table 9
Experiment 2, Beliefs About the Brain by Group

Brain belief	Essentializers	Non-essentializers
Those with different learning styles use different brain regions to learn.	**4.10 (.72)****	**3.86 (.90)****
The characteristics of a person's brain during early childhood is the largest determining factor of their learning style as an adult.	**3.61 (.85)****	3.02 (1.02)
A person's learning style is better predicted by their life experiences than their brain's characteristics. (RE)	3.05 (.93)	2.63 (.97) **
People who have different learning styles have measurable differences in certain brain regions (for example, size, density, or blood flow).	**3.63 (.92)****	2.85 (1.13)
There are no substantial differences between the brains of those with different learning styles. (RE)	**3.42 (1.06)****	3.04 (1.17)
Brain imaging can be used to identify a person's learning style.	**3.50 (.98)****	2.99 (1.04)
Average score	**3.55 (.57)****	3.06 (.63)

Note. RE = reverse coded. *SD*s are in brackets. Above-midpoint items are bolded.
** Test against midpoint is significant at the corrected .008 level (two tailed).

using brain imaging. They were also more likely than the nonessentializers to endorse that people with different learning styles use different brain regions to learn. Unlike the essentializers, the nonessentializers were below the midpoint on all brain items except one, indicating that they did not appear to hold strong beliefs that learning styles are instantiated in the brain. Surprisingly, neither the essentializers nor the nonessentializers strongly endorsed the idea that the characteristics of one's brain outweigh life experience in determining one's learning style, and both groups believed that those with different learning styles use different brain regions to learn (see Table 9).

To summarize, those who endorse learning styles appear to share the belief that learning styles are instantiated in the brain in some way. Namely, most believers agreed that those with different learning styles use different brain regions to learn. This supports the assumption that belief in learning styles does entail some beliefs about brain function. However, we found significant differences between the essentializers and the nonessentializers in how many assumptions about the brain they strongly endorsed. These patterns suggest that those holding stronger essentialist beliefs about learning styles are more likely to view learning styles as detectable and measurable in the brain and as such from early childhood. At the same time, our findings regarding the role of life experience in determining one's learning styles again replicate the findings from earlier analyses, suggesting that most people view learning as somewhat influenced by experience.

Switched-at-Birth Beliefs

Prior work shows that having strong essentialist beliefs about human traits includes viewing those traits as highly heritable and uninfluenced by experiences such as rearing (see Gelman et al., 1991; Solomon et al., 1996; Taylor et al., 2009). However, our present findings suggest some inconsistency in such beliefs. For example, the analyses reported thus far indicate that people agree both that learning styles are predisposed at birth and that they can change with experience (see Parts One and Three for both Experiments 1 and 2). To examine this inconsistency, we also use a SWAB task, which has an advantage over our survey items by concretely and directly pitting heritability and rearing experience against each other. Specifically, we predicted that those who more highly essentialized learning styles would be more likely to judge that a child's learning style was inherited from their parents as opposed to learned from their adopted parents.

To begin, three scores were created by averaging participants' ratings: one biological score representing how the biological parents' learning style was rated, one adoptive score representing how the adoptive parents' learning style was rated, and one other score representing how the third, unmentioned learning style was rated. Next, we conducted a repeated-measures ANOVA to examine the effects of score type (biological, adoptive, other) on participants' ratings of likelihood. We also included group (essentializer or nonessentializer) as a between-subjects variable to examine potential relations between essentialist beliefs and SWAB performance. Given our interest in educators' beliefs, occupation (educator vs. noneducator) was also included as an independent variable.

Analyses revealed a main effect of score type (biological, adoptive, other) on participants' ratings ($F[2, 332] = 91.66$, $p < .001$, η^2; = .35) and a score type by group interaction ($F[2, 332] = 40.32$, $p < .001$, η^2; = .11). There was no main effect of group ($F[1, 332] = 1.09$, $p = .29$, occupation, $F[1, 343] = .039$, $p = .84$) or interactions with occupation (all ps $> .34$). Paired-samples t tests confirmed a different pattern of responding between the essentializers and the nonessentializers, with all pairwise comparisons significant at the Bonferroni-corrected level of .005 (i.e., .05 divided by 9). The essentializers rated the biological learning style the highest, the adoptive learning style the second highest and the other learning style the lowest. In contrast, the nonessentializers rated the adoptive learning style the highest, the biological learning style the second highest, and the other learning style the lowest. Table 10 provides a summary of these findings.

These patterns suggest that those who more highly essentialized learning styles were more likely to view learning styles as heritable and less influenced by rearing experience. However, it is worth noting that biological and adoptive learning styles both received fairly high ratings across both groups.

Table 10
Experiment 2, Switched-at-Birth (SWAB) Task, Score by Group

Score	Essentializers	Nonessentializers
Biological	**3.83 (.76)**	3.30 (.72)
Adoptive	3.42 (.82)	**3.77 (.63)**
Other	2.49 (.67)	2.83 (.72)

Note. *SD*s are provided in brackets. Highest value is bolded. Likert scale 1 to 5.

General Discussion

In two experiments, we sought to understand the potential role of essentialism in people's interpretation of the learning style myth. Our findings make a substantial contribution to what is known about learning style beliefs. Prior work has focused mainly on people's beliefs about the existence of learning styles (e.g., Dekker et al., 2012; Dündar & Gündüz, 2016; Newton, 2015). The underlying assumption of such work was that those who endorse learning styles likely hold similar beliefs about them. The present findings partly support this assumption by showing that those who believe in learning styles share a set of core beliefs, but they also partly contradict this assumption by demonstrating that some beliefs among those endorsing learning styles are highly variable. For clarity, we review our specific findings below and discuss their implications in turn.

The Learning Style Myth

Despite decades of research on learning styles (see Pashler et al., 2008 for a review), our findings are the first to extensively investigate lay beliefs about the essentialism of learning styles. We found that those who endorse learning styles answered similarly on many items on our scales. People held similar beliefs about their own and others' dominant learning styles, with people believing that only two learning styles are predominant (visual and kinesthetic). They generally agreed that those with different learning styles use different brain regions to learn. They generally agreed that learning styles predict school outcomes, predict teachers from whom people learn best, are detectable as a child, and are instantiated in the brain. They generally disagreed with the essentialist assumptions that one's learning style is not influenced by experience, that people generally have a single learning style and that one's learning style remains the same across contexts (e.g., school subjects; see items with more than 75% agreement, Experiments 1 and 2). Based on these patterns of findings, it seems that those who endorse the existence of learning styles typically view them as an early emerging tendency to learn in a certain modality or combinations of modalities that is shaped by one's brain function and experience and that predicts outcomes in school settings. These findings offer a new starting point for research on learning style philosophies. They suggest that the majority of believers may view learning styles as less mutually exclusive and more malleable than researchers have previously recognized (e.g., Husmann et al., 2018; Newton, 2015; Pashler et al., 2008).

One potential concern with the present investigation is that participants may have been reasoning not about learning styles per se but rather about other constructs that are well established, such as that some people have more efficient visual or auditory working memories than others (Jensen, 1971). However, there are two reasons to doubt that this was the case. First, at the start of the survey, participants read a clear and explicit definition of learning styles. This definition was based on prior investigations of neuromyths that include learning styles (e.g., Dekker et al., 2012; Newton et al. 2017; Tardif et al., 2015). Second, considering complex factors like working memory capacity requires significant knowledge of the science of learning. However, prior work on lay beliefs about learning and the brain suggests that the general public lacks insight into the mechanisms that underlie learning (see Bjork, Dunlosky, & Kornell, 2013; Pasquinelli, 2012 for reviews). A related possibility was that participants may have been reasoning about others' learning style preferences. However, there is no evidence that matching instruction to one's preferences correlates with learning outcomes—especially across a wide variety of learning contexts (Krätzig et al., 2006). Regardless, even if participants were considering slightly different definitions of learning styles, our findings are still meaningful because they establish that some people are more likely than others to essentialize how students learn.

A final related concern is that participants might have reasoned about learning style preferences without believing that those preferences have effects on learning or life outcomes. A core tenet of the meshing hypothesis is that meshing a style to a learning setting affects learning outcomes. However, some of our survey items rule out this concern. Specifically, in both experiments, the majority of participants agreed that learning styles predict career outcomes, the settings in which students learn best, and the teachers from whom students learn best. These findings provide strong evidence that learning styles are not viewed by our participants as merely benign preferences that have no effect on life and learning.

Essentialism of Learning Styles

Our findings also revealed significant variability in people's beliefs about learning styles. Across both of our experiments, we discovered two groups of believers—essentializers and nonessentializers. The groups showed different patterns of responding on the essentialism survey, brain-belief items, and SWAB task. A strict essentialist interpretation of learning styles would lead people to believe that learning styles are early emerging, have a biological or genetic basis, are instantiated in the brain, mark distinct kinds of learners, predict learning and life outcomes, and are not influenced by experience. The essentializers were much closer to holding this view of learning styles than the nonessentializers. The essentializers were more likely to view learning styles as determined at birth, unchanging, detectable in the genes, heritable, mutually exclusive, marking distinct kinds of people, instantiated in the brain, and predictive of career and school outcomes (cluster analyses, Experiments 1 and 2). Although this group acknowledged some influence of experience on one's learning style, follow-up questions revealed they believed that inheritance more strongly influences one's learning style than rearing experience (SWAB task, Experiment 2, see essentializers). Together these findings suggest that some people are more likely than others to view learning styles in an essentialist light and thus as having a biological essence that marks distinct kinds of people and as less influenced by experience.

A promising area for future work will be examining whether interpreting learning styles in a more essentialist manner might lead people to be less receptive to debunking efforts. Prior work has found that some people are more reluctant than others to revise their beliefs about learning styles (Macdonald, Germine, Anderson, Christodoulou, & McGrath, 2017). For example, in a recent study in which postsecondary educators were shown evidence of the ineffectiveness of learning styles, 32% stated they would continue to use learning styles in the classroom despite the evidence they were shown (Newton et al., 2017). It is possible that those holding a more essentialist interpretation of learning styles may be less receptive to counterevidence. For example, it may be

difficult for people to accept that learning styles are ineffective if that also entails revising a host of strong beliefs about how they are instantiated in the brain, influence learning outcomes, and mark distinct kinds of people (for a similar proposal about revising entrenched theories, see Carey, 2009).

The present work examined the beliefs of those in the United States only. As reviewed earlier, learning style beliefs are present in many educational systems across the globe (Coffield et al., 2004; Dekker et al., 2012; Dündar & Gündüz, 2016; Gleichgerrcht et al., 2015; Morehead et al., 2016; Pei et al., 2015; Rato et al., 2013; Scott, 2010; Tardif et al., 2015). Given that the present findings indicate local variability in learning style beliefs, it seems likely that there is also global variability. It will also be important for future work to examine cross-cultural differences in how learning styles are construed. Our essentialism survey may provide one tool for examining such differences.

Learning Styles as a Neuroscience Myth

Our studies are the first, to our knowledge, to examine people's beliefs about the instantiation of learning styles in the brain. Our findings confirm the previously untested assumption that endorsement of learning styles entails the belief that learning styles are likely instantiated in the brain in some way. As discussed earlier, people generally agreed with the incorrect statement that those with different learning styles use different brain regions to learn (Experiment 2).

People's beliefs about the brain were predicted by whether or not they were an essentializer. The essentializers rated five of six potential discoveries about the brain significantly above the midpoint, whereas the nonessentializers rated only one of six significantly above the midpoint (Experiment 2). Overall, those who held more essentialist beliefs about learning styles viewed learning styles as easier to detect in the brain and more highly influenced by brain function (Experiment 2). These findings demonstrate that belief about the brain varies widely among those who endorse learning styles and is predicted by the degree to which they hold essentialist beliefs about learning styles. It will be important for future work to determine whether people hold similar beliefs about how other neuromyths operate in the brain about which we know similarly little (for a list see Dekker et al., 2012).

Educators' Beliefs

We were interested in comparing the beliefs of educators with those of noneducators, given that educators' beliefs potentially have direct consequences for their interactions with students. Overall, educators were slightly less likely to endorse learning styles than noneducators. However, among those who endorsed learning styles, a similar pattern of findings was found across both samples. Educators were just as likely as noneducators to engage in essentialist and incorrect thinking about the brain (Experiment 2). As with noneducators, they fell into two groups, with essentializers engaging in more incorrect thinking about inheritance and the brain (Experiment 2). Together these findings suggest that despite daily experience with students in an educational setting, educators are just as likely as noneducators to reason incorrectly about learning styles. These findings support previous work showing that educators are equally susceptible to neuroeducational myths (e.g., Dekker et al., 2012; Dündar & Gündüz, 2016; Gleichgerrcht et al., 2015; Morehead et al., 2016).

Only one educator-specific factor predicted educators' learning style beliefs—student population. Specifically, we found that those who work with younger students reason in a more essentialist manner about learning styles than those who work with older students. Unfortunately, sample size prevented us from a more fine-grained analysis comparing the beliefs of teachers at different levels (i.e., comparing preschool educators to elementary educators, etc.). Qualitatively, educators' beliefs appeared to shift from preschool to elementary school and from middle school to high school, with the following percentages of each educator type falling into the essentializer group: 88% of preschool educators, 59% of elementary educators, 57% of middle school educators, 32% of high school educators, and 42% of postsecondary educators. Why this is the case is currently unclear. One possibility is that learning style philosophies may be more relevant to the educational practices of younger years' educators because of differences in classroom composition. At the high school and postsecondary levels, classes are grouped by achievement level (e.g., advanced vs. vocational), whereas at younger levels there are typically children of highly varied ability levels in one classroom. In grappling with how best to teach children at widely varying ability or skill levels, teachers might find themselves searching for ways to categorize learners into distinct types—including learning styles. However, whether this is the case is unknown. This finding provides many questions for future research.

Surprisingly, the other demographic factors we measured did not significantly predict learning style beliefs. These factors included age, gender, parental status, and level of education. We discovered great stability in the distribution of beliefs across demographic groups in our sample. Prior work on the essentialism of intelligence and personality traits has also failed to find large effects of demographic factors like race, education, and gender (Gelman et al., 2007; Thomas et al., 2015). Future work should further investigate what factors predict essentialist thinking about learning styles. One promising factor may be the degree to which people hold a fixed or growth mindset (e.g., Dweck, 2000) because prior work suggests that there is a relation between holding an entity mindset and holding essentialist beliefs (Thomas et al., 2015).

Conclusion

In two experiments, the present investigation explored the role of psychological essentialism in people's beliefs about learning styles. It tested the possibility that learning style beliefs may reflect essentialist thinking about how people learn. Our findings reveal that belief in learning styles among both educators and noneducators is far more complex and variable than previously recognized. Roughly half the people we tested endorsed a set of essentialist beliefs about learning styles: that they are easily detectable and measurable in the brain, determined at birth, heritable, and predictive of life outcomes. In contrast, the others endorsed looser, nonessentialist beliefs about learning styles as malleable, overlapping, and determined by environmental factors. The present studies provide a new starting point for research on learning styles and suggest that future research on neuroscience-based myths needs to move beyond merely assessing the rate at which they are endorsed.

References

Bjork, R. A., Dunlosky, J., & Kornell, N. (2013). Self-regulated learning: Beliefs, techniques, and illusions. *Annual Review of Psychology, 64,* 417–444. http://dx.doi.org/10.1146/annurev-psych-113011-143823

Carey, S. (2009). *The origin of concepts*. New York, NY: Oxford University Press.

Cheung, B. Y. (2016). *Out of my control: The effects of perceived genetic etiology* (Unpublished Doctoral dissertation). University of British Columbia, Vancouver, British Columbia, Canada.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning styles and pedagogy in post-16 learning: A systematic and critical review*. London, United Kingdom: Learning and Skills Research Centre.

Dekker, S., Lee, N. C., Howard-Jones, P., & Jolles, J. (2012). Neuromyths in education: Prevalence and predictors of misconceptions among teachers. *Frontiers in Psychology, 3,* 429. http://dx.doi.org/10.3389/fpsyg.2012.00429

Dembo, M. H., & Howard, K. (2007). Advice about the use of learning styles: A major myth in education. *Journal of College Reading and Learning, 37,* 101–109. http://dx.doi.org/10.1080/10790195.2007.10850200

Dündar, S., & Gündüz, N. (2016). Misconceptions regarding the brain: The neuromyths of preservice teachers. *Mind, Brain and Education: the Official Journal of the International Mind, Brain, and Education Society, 10,* 212–232. http://dx.doi.org/10.1111/mbe.12119

Dweck, C. (2000). *Self-theories: Their role in motivation, personality, and development* (1st ed.). Lillington, NC: Psychology Press.

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought. Oxford Series in Cognitive Development*. New York, NY: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195154061.001.0001

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. http://dx.doi.org/10.1111/j.1467-8624.2007.01031.x

Gelman, S. A., & Wellman, H. M. (1991). Insides and essences: Early understandings of the non-obvious. *Cognition, 38,* 213–244. http://dx.doi.org/10.1016/0010-0277(91)90007-Q

Gleichgerrcht, E., Lira Luttges, B., Salvarezza, F., & Campos, A. L. (2015). Educational neuromyths among teachers in Latin America. *Mind, Brain and Education, 9,* 170–178. http://dx.doi.org/10.1111/mbe.12086

Google Public Data. (2018). Retrieved from https://trends.google.com/trends/explore?q=learning%20styles

Grigorenko, E. L., & Sternberg, R. J. (1997). Styles of thinking, abilities, and academic performance. *Exceptional Children, 63,* 295–312. http://dx.doi.org/10.1177/001440299706300301

Haslam, N., Rothschild, L., & Ernst, D. (2000). Essentialist beliefs about social categories. *British Journal of Social Psychology, 39,* 113–127. http://dx.doi.org/10.1348/014466600164363

Heine, S. J., Dar-Nimrod, I., Cheung, B. Y., & Proulx, T. (2017). Essentially biased: Why people are fatalistic about genes. *Advances in Experimental Social Psychology, 55,* 137–192. http://dx.doi.org/10.1016/bs.aesp.2016.10.003

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences, 33,* 61–83. http://dx.doi.org/10.1017/S0140525X0999152X

Husmann, P. R., & O'Loughlin, V. D. (2018). Another nail in the coffin for learning styles? Disparities among undergraduate anatomy students' study strategies, class performance, and reported VARK learning styles. *Anatomical Sciences Education, 12,* 6–19.

Jensen, A. R. (1971). Individual differences in visual and auditory memory. *Journal of Educational Psychology, 62,* 123–181. http://dx.doi.org/10.1037/h0030655

Kirschner, P. A., & van Merriënboer, J. J. (2013). Do learners really know best? Urban legends in education. *Educational Psychologist, 48,* 169–183. http://dx.doi.org/10.1080/00461520.2013.804395

Knoll, A. R., Otani, H., Skeel, R. L., & Van Horn, K. R. (2017). Learning style, judgements of learning, and learning of verbal and visual information. *British Journal of Psychology, 108,* 544–563. http://dx.doi.org/10.1111/bjop.12214

Kozhevnikov, M., Hegarty, M., & Mayer, R. E. (2002). Revising the visualizer-verbalizer dimension: Evidence for two types of visualizers. *Cognition and Instruction, 20,* 47–77. http://dx.doi.org/10.1207/S1532690XCI2001_3

Krätzig, G. P., & Arbuthnott, K. D. (2006). Perceptual learning style and learning proficiency: A test of the hypothesis. *Journal of Educational Psychology, 98,* 238–246. http://dx.doi.org/10.1037/0022-0663.98.1.238

Lapp, D., Flood, J., & Fisher, D. (1999). Visual literacy: Intermediality: How the use of multiple media enhances learning. *Reading Teacher, 52,* 776–780.

Lethaby, C., & Harries, P. (2015). Learning styles and teacher training: Are we perpetuating neuromyths? *ELT Journal, 70,* 16–27. http://dx.doi.org/10.1093/elt/ccv051

Lujan, H. L., & DiCarlo, S. E. (2006). First-year medical students prefer multiple learning styles. *Advances in Physiology Education, 30,* 13–16. http://dx.doi.org/10.1152/advan.00045.2005

Macdonald, K., Germine, L., Anderson, A., Christodoulou, J., & McGrath, L. M. (2017). Dispelling the myth: Training in education or neuroscience decreases but does not eliminate beliefs in neuromyths. *Frontiers in Psychology, 8,* 1314. http://dx.doi.org/10.3389/fpsyg.2017.01314

Massa, L. J., & Mayer, R. E. (2006). Testing the ATI hypothesis: Should multimedia instruction accommodate verbalizer-visualizer cognitive style? *Learning and Individual Differences, 16,* 321–335. http://dx.doi.org/10.1016/j.lindif.2006.10.001

Mayer, R. E. (2002). Multimedia learning. In B. H. Ross (Ed.), *Psychology of Learning and Motivation, 41,* 85–139. http://dx.doi.org/10.1016/S0079-7421(02)80005-6

McCabe, J. A. (2018). What learning strategies do academic support centers recommend to undergraduates? *Journal of Applied Research in Memory & Cognition, 7,* 143–153. http://dx.doi.org/10.1016/j.jarmac.2017.10.002

Medin, D. L., & Ortony, A. (1989). Psychological essentialism. In S. Vosniadou and A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 179–195). New York, NY: Cambridge University Press.

Morehead, K., Rhodes, M. G., & DeLozier, S. (2016). Instructor and student knowledge of study strategies. *Memory, 24,* 257–271. http://dx.doi.org/10.1080/09658211.2014.1001992

Moreno, R., & Mayer, R. E. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity. *Journal of Educational Psychology, 91,* 358–368. http://dx.doi.org/10.1037/0022-0663.91.2.358

Newton, P. M. (2015). The learning styles myth is thriving in higher education. *Frontiers in Psychology, 6,* 1908. http://dx.doi.org/10.3389/fpsyg.2015.01908

Newton, P. M., & Miah, M. (2017). Evidence-based higher education: Is the learning styles myth important? *Frontiers in Psychology, 8,* 444. http://dx.doi.org/10.3389/fpsyg.2017.00444

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest, 9,* 105–119. http://dx.doi.org/10.1111/j.1539-6053.2009.01038.x

Pasquinelli, E. (2012). Neuromyths: Why do they exist and persist? *Mind, Brain and Education: the Official Journal of the International Mind, Brain, and Education Society, 6,* 89–96. http://dx.doi.org/10.1111/j.1751-228X.2012.01141.x

Pei, X., Howard-Jones, P. A., Zhang, S., Liu, X., & Jin, Y. (2015). Teachers' understanding about the brain in East China. *Procedia: Social and Behavioral Sciences, 174,* 3681–3688. http://dx.doi.org/10.1016/j.sbspro.2015.01.1091

Punj, G., & Stewart, D. W. (1983). Cluster analysis in marketing research: Review and suggestions for application. *Journal of Marketing Research, 20,* 134–148. http://dx.doi.org/10.1177/002224378302000204

Pyryt, M. C., Sandals, L. H., & Begoray, J. (1998). Learning style preferences of gifted, average-ability, and special needs students: A multivariate perspective. *Journal of Research in Childhood Education, 13,* 71–76. http://dx.doi.org/10.1080/02568549809594728

Rato, J. R., Abreu, A. M., & Castro-Caldas, A. (2013). Neuromyths in education: What is fact and what is fiction for Portuguese teachers? *Educational Research, 55,* 441–453. http://dx.doi.org/10.1080/00131881.2013.844947

Rhodes, M., & Mandalaywala, T. M. (2017). The development and developmental consequences of social essentialism. *Wiley Interdisciplinary Reviews: Cognitive Science, 8,* 1437–1455. http://dx.doi.org/10.1002/wcs.1437

Rogowsky, B. A., Calhoun, B. M., & Tallal, P. (2015). Matching learning style to instructional method: Effects on comprehension. *Journal of Educational Psychology, 107,* 64–78. http://dx.doi.org/10.1037/a0037478

Scott, C. (2010). The enduring appeal of learning styles. *Australian Journal of Education, 54,* 5–17. http://dx.doi.org/10.1177/000494411005400102

Sharp, J. G., Bowker, R., & Byrne, J. (2008). VAK or VAK-uous? Towards the trivialisation of learning and the death of scholarship. *Research Papers in Education, 23,* 293–314. http://dx.doi.org/10.1080/02671520701755416

Solomon, G. E., Johnson, S. C., Zaitchik, D., & Carey, S. (1996). Like father, like son: Young children's understanding of how and why offspring resemble their parents. *Child Development, 67,* 151–171. http://dx.doi.org/10.2307/1131693

Tardif, E., Doudin, P. A., & Meylan, N. (2015). Neuromyths among teachers and student teachers. *Mind, Brain and Education, 9,* 50–59. http://dx.doi.org/10.1111/mbe.12070

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. http://dx.doi.org/10.1111/j.1467-8624.2009.01272.x

Thomas, A. J., & Sarnecka, B. W. (2015). Exploring the relation between people's theories of intelligence and beliefs about brain development. *Frontiers in Psychology, 6,* 921. http://dx.doi.org/10.3389/fpsyg.2015.00921

Zhang, L. F., & Sternberg, R. J. (2000). Are learning approaches and thinking styles related? A study in two Chinese populations. *Journal of Psychology, 134,* 469–489. http://dx.doi.org/10.1080/00223980009598230

Received September 12, 2018
Revision received April 5, 2019
Accepted April 6, 2019 ■