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"If it's in your mind, it's in your knowledge": Children's developing anatomy of identity

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Abstract

Recent work has investigated children's developing understanding of the anatomical locus of identity. In two studies, we extend this work by exploring the role of the mind as opposed to the brain in children's conceptualization of identity. In Experiment 1, an analysis of natural language indicated that adults use the term *mind* more frequently than the term *brain* with reference to identity-related mental processes. Children's output displayed a similar bias. In Experiment 2, we compared the judgments of 5- and 7-year-old children to those displayed by adults. Participants heard stories in which a magical transformation resulted in either a creature with a mismatch between brain and body or a creature with a mismatch between mind and body. Children were more accurate in recognizing the enduring identity of this transformed creature when the transformation resulted in a mismatch between mind and body as compared to brain and body.

Keywords: Mind; Brain; Body; Personal identity

> "Now when she had given them the potion, and they had drunk it off, then she presently smote them with her wand, and penned them in the sties. And they had the heads, and voice, and bristles, and shape of swine, but their minds remained unchanged even as before." (Homer)

A major issue in Western philosophy is the question of what it takes for each of us to retain our personal identity over time. The dominant philosophical answer to that question has generally focused on psychological continuity (Olson, 2003). More specifically, it is claimed that we retain our personal identity over time because we retain many of our earlier

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mental features, such as our thoughts, memories, and preferences. A major appeal of this proposal is that it fits our assumption that we retain our personal identity even though our bodies and outward appearance change radically over the course of a lifetime

Do young children assume that a person's enduring identity depends on psychological continuity? For example, when they look at a photograph of their mother as a child, do they understand that the child in the photograph and their mother are one and the same person even though processes of growth and ageing have brought about dramatic differences in outward appearance? Somewhat surprisingly, given the long-standing emphasis on psychological continuity in philosophy, recent research on children's concept of personal identity has mainly focused on the brain as a seat of continuity rather than the mind. In particular, two studies (Gottfried, Gelman, & Schultz, 1999; Johnson, 1990) have used a brain transplant paradigm to explore children's ideas about enduring identity. Motivated by Popper and Eccles' (1977) thought experiments and Keil's (1989) work on children's kind membership judgments, Johnson (1990) focused on a series of hypothetical body-part "swaps" (transplants). In one of these studies, Johnson asked children to imagine that their brain had been put into the body of a pig. When children were invited to make various judgments about the resultant pig-with-a-child's brain, a marked age change emerged. Few 5-year-olds but most 7-year-olds judged that the creature would display the characteristic memories, preferences, and behaviors of a child rather than a pig. A similar age change emerged when children were asked to say whether the creature would claim to be a pig or a child.

In a series of four follow-up studies, Gottfried et al. (1999) compared children's identity judgments with respect to either a brain transplant or an "insides" transplant. Five- and 6-year-olds, 6- and 7-year-olds, 8- and 9-year-olds, and adults, listened to a story in which a brain from one animal (e.g., a cow) was transferred into the body of a second, previously brainless animal (e.g., a horse). Participants were then asked about the resulting animal's brain-based characteristics (thoughts, memories, dwelling preference) and body-based characteristics (appearance, vocalization, brain size, and stomach contents). As reported by Johnson (1990), a transition to a brain-based view of identity emerged between the ages of 5 and 8.

However, as Johnson (1990) noted, stories involving a magical transformation in which the body is changed while the mind is preserved are prevalent in folk tales as early as the time of Homer (see opening quote). Such tales suggest that Western humans may have viewed the mind as the seat of an individual's stable identity long before there was any systematic appreciation of the intimate relationship between the mind and the brain. It is conceivable that there is a similar décalage between mind and brain in the case of children's concept of personal identity. Colloquial phrases regarding mental functions frequently contain the word *mind* (e.g., *change your mind*, *make up your mind*, *use your mind*, *remind*, *never mind*, *out of your mind*, *on your mind*, *losing your mind*), whereas few contain the word *brain* (e.g., *brainy*, *use your brain*). Thus, children may first link various key mental functions such as thinking, remembering and wanting with the mind rather than the brain. To the extent that children think of a person's enduring identity as tied to their mental functioning—their thoughts, memories, and preferences—they would come to think of that identity as dependent on the person's mind—even in the face of bodily growth and transformation. Thus, although the results reported by Johnson (1990) and Gottfried et al. (1999) clearly show that

children eventually come to appreciate the intimate relationship between brain and identity, it may be that children initially find it easier to conceptualize the relationship between mind and identity.

We examined this proposal in two successive studies. In Experiment 1, we examined naturally occurring conversations between parents and children in order to check two hypotheses (i) that children receive more linguistic input about the role of the mind than the brain with respect to a variety of mental functions, including deciding, remembering, thinking, and dreaming and (ii) that children themselves proceed to generate more linguistic output regarding the role of the mind than the brain with respect to these various mental functions. In Experiment 2, we examined the understanding of personal identity more directly. Children aged 5 and 7 years, and for comparison purposes, a group of adults, were told about two different types of magical transformation. One transformation resulted in a creature whose brain did not match his or her body. The other transformation resulted in a creature whose mind did not match his or her body. In line with earlier findings, we anticipated that 7-year-olds would be more accurate in recognizing the enduring identity of the transformed creature than 5-year-olds. We further hypothesized that children would make more accurate identity judgments concerning the mind/body mismatch than the brain/body mismatch.

1. Experiment 1

In Experiment 1, we examined the input that children hear and the output that they produce about the mind and brain through an analysis of CHILDES data (MacWhinney, 2000). In an earlier analysis of these data, Gottfried and Jow (2003) targeted the word *brain* and found that it occurs relatively infrequently in children's linguistic input, as compared to other organ words such as *heart*, *eyes*, and *stomach*. Their results also revealed that the word *brain* is not generally used in connection with mental processes. Only 26% of references to the brain were coded as mentalistic, as compared to 37% of references to the heart. We targeted the word *mind* as well as the word *brain*. We expected to replicate Gottfried and Jow's (2003) finding of infrequent input containing the word *brain*. We also expected to confirm two hypotheses, namely that children receive more linguistic input about the role of the mind than the brain in various mental functions and that children themselves also generate more comments about the role of the mind than the brain in various mental functions.

1.1. Method

1.1.1. Participants

Transcripts from four native English-speaking children provided the conversations analyzed in this study. Transcripts were selected from CHILDES (MacWhinney, 2000), a computerized database of children's speech samples. To replicate the findings of Gottfried and Jow (1999), we selected the same four corpora used in their study, truncating the Ross corpus (MacWhinney, 2000) at 5 years 4 months. The four children ranged in age from 2 years 3 months to 5 years 4 months (see Table 1). Speech samples were collected in sessions

Table 1
Experiment 1, data collection procedures for each child

Child	Contributor	Collection procedure	Age range	Demographic/SES
Adam	Brown (1973)	1–2 h every 2 weeks	2;3–4;10	First-born African American male, middle class
Abe	Kuczaj & Maratsos (1975)	1 h every week until 4;0, 1/2 h a week until 5;0	2;4–5;0	First-born white male, graduate student
Sarah	Brown (1973)	1/2 h one to two times per week	2;3–5;1	First-born white female, working class
Ross	MacWhinney (2000)	Multiple episodes every 2–3 weeks	2;6–5;4	First-born white male, college professor

ranging from 1/2 to 2 h every 1–3 weeks. All speech samples came from children's everyday conversations with parents, siblings, and other visitors, and were recorded at home during routine activities. All four of the participants were first-born, and were raised in two-parent families in the United States (for additional descriptions see Bartsch & Wellman, 1995; Brown, 1973; Kuczaj, 1976; MacWhinney, 2000).

1.1.2. Search materials and procedure

To identify the frequency and nature of references to brain and mind, we searched the database for all utterances that explicitly mentioned the terms *brain* and *mind*. We included references made to the child by an interlocutor (input) and references made by the child (output). Target terms included the primary terms of *brain* and *mind* and words with those roots (e.g., *brains*, *minds*).

A computerized search located every utterance containing at least one of the two target terms. Coding was based on an examination of the target utterance together with the five utterances preceding and the five utterances following the target utterance in order to obtain a larger context for each reference. The extended transcripts (beyond five utterances before and after the target utterance) were consulted for those utterances where further clarification was necessary.

1.1.2.1. Coding. We first assigned each target utterance to one of two mutually exclusive categories: output or input. Utterances spoken by the target child were coded as output; all other utterances were coded as input.

Second, we examined whether utterances were made during book reading. There was only one instance of this in the sample: when Ross and his father were reading a Star Wars book (Ross [4;0]: "At that same moment as Luke was training a frightening vision was formed in his *mind*"). Additionally, three of the uses of the target terms were in reference to *Brainy Smurf*. These four utterances were excluded from further analysis. Before the removal of these references, we confirmed Gottfried and Jow's (2003) finding of 23 brain utterances in the input to children.

The remaining utterances were examined on three dimensions. We first coded utterances as mental (i.e., those utterances that included a reference to a specific mental state or process) or non-mental. Utterances coded as *non-mental* included:

Ursula: No but he's in the first grade in a different school.
Adam (4;9): Oh yeah feather *brain*.
Mother: Oh that's not nice to say.

Father: Check them out Ross.
Father: See if his *brains* are okay.
Ross (4;4): They're broken.

Next, the utterances that were coded as mental were further analyzed with respect to the specific mental function referred to. Six mental functions were identified: control, decision, memory, sanity, cognition, and dreams. These functions are described in further detail below.

Control. These were references to the mind/brain as the locus of motor and thought control. Only two utterances fell into this category, both from the Ross corpus. An example is:

Father: Are you sure you won't try to move it around?
Ross(4;6): Yeah.
Father: How do you know?
Ross(4;6): Because of my *brains*.
Father: Your *brains* will stop you from doing it?

Decision. This category included the two, frequently occurring phrases *change your mind* and *make up your mind*.

Memory. These were references to the mind/brain as a locus of memory, including use of the word *remind*. For example:

Father: How do you remember it?
Ross (4;4): In my *mind*.

Sanity. These were references associating the mind/brain with mental stability. They occurred only in the Sarah corpus. An example is.

Sarah: (4;2): Which one I'm lookin for?
Mother: You're out of your *mind*.

Cognition. These were references to the mind/brain as an organ for generating or containing knowledge and ideas. For example:

Mother: What are you thinking about?
Abe (3;3): Nothin.

Mother: What was on your *mind*?
Father: If it's not in your *mind* then it's not in your knowledge.
Ross(5;0): Cause if it's in your *mind* it's in your knowledge.

Dreams. There was only one reference to the mind/brain as a locus of dreams. This occurred in Abe (3;10):

Father: How can you see 'em then if your eyes are closed?
Abe (3;10): It just happens and your eyes make dreams.
Father: Oh.

Mother: I always thought my dreams happened in my *mind* remember?

Finally, to investigate the extent to which children were aware of the mind and brain as associated with particular body parts, we identified utterances that made specific reference to the presumed *anatomical location* of the mind or brain. For utterances coded as anatomical, the body part referred to was noted. For example, the following utterances were coded as anatomical:

Father: Maybe Marky has his *brains*.
Ross(4;4): Why?
Father: He didn't lose them because nobody hit him on the head.

Mother: What does feather *brain* mean?
Adam (4;9): You know Indians.
Mother: Oh.
Mother: Because Indians have feathers around their *brains*?

1.1.3. Reliability

Two coders (the authors K.C. and E.P.) independently coded the brain and mind utterances from all four children. Inter-rater agreement for coding was calculated by dividing the total number of agreements by the total number of coding decisions to be made (i.e., three times the total number of utterances). The resulting inter-rater agreement was 98%. Disagreements were resolved by discussion.

1.2. Results

1.2.1. Overall results

Across all corpora and speakers, there were 185 references to *mind*, but only 36 references to *brain*. Of the 185 mind utterances, only a small proportion (.08) were uses of *remind*, indicating that the high frequency of mind utterances was not due to the inclusion of this term. The proportion of mind and brain utterances in input that included the word *mind* (.83) was significantly greater than the proportion of utterances that included the word *brain* (.17), according to a binomial test ($p < .001$). Children's output followed the same pattern, with the proportion of mind utterances (.84) exceeding the proportion of brain utterances (.16) ($p < .001$). Table 2 shows the frequency of mind and brain utterances in input and output, collapsing across the four corpora.

Table 2
Frequency of references to the brain and mind, and frequency of references to mental functions, for input and output (collapsed across four children)

	Brain	Mind
Input ($N = 131$)	22	109
Mental Function	6	45
Output ($N = 90$)	14	76
Mental Function	3	29
Total	36	185

References to mental functions were more frequently included in mind utterances. Across all corpora and speakers, only nine brain utterances included a reference to a mental function, whereas 74 mind utterances did so. Table 2 shows the overall number of input and output utterances for each of the two target terms. A binomial test confirmed that for input, the proportion of references to mental functions that featured the word *mind* (.88) was greater than the proportion of references to mental functions that featured the word *brain* (.12) ($p < .001$). Similarly, for child output, the proportion of references to mental functions that featured the word *mind* (.91) was greater than the proportion of references to mental functions that featured the word *brain* (.09) ($p < .001$). Although these findings might be expected due to the greater overall frequency of mind utterances, the proportion of mind utterances that included a reference to mental functions was greater than the proportion of brain utterances that did so, both for input (mind = .42; brain = .27) and output (mind = .38; brain = .21). This implies that, not only do children receive more input that includes the term *mind* than the term *brain*, but that mind input is more likely than brain input to refer to mental functions. The same asymmetry holds for child output.

1.2.2. Analysis of mental function references by age

In order to explore how the distribution of mental references varied with age, mental references were grouped by the age of the child in years. Because only one child (Ross) was recorded up to the age of 5 years 4 months, utterances that fell after the child's fifth birthday were not included in the analysis. Fig. 1 shows the frequency of mind and brain utterances in input and output that occurred during children's third, fourth, and fifth years.

The number of mental references that children heard increased with age for both mind and brain but the earliest references (in the third year) were to the mind. Children themselves made no mind utterances in the third year, but displayed a sharp increase in such references between the fourth and fifth year. References to the brain appeared only in the fifth year.

1.2.3. Analysis of references to mental functions

Mental references were coded into six mental functions. Fig. 2 shows the frequency of references to six mental functions for brain and mind utterances in the input that children received. References to mental function for mind utterances were most frequent

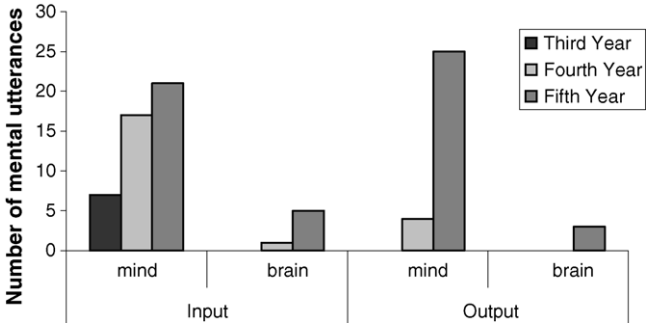

Fig. 1. Frequency of mind and brain utterances in input and output by age.

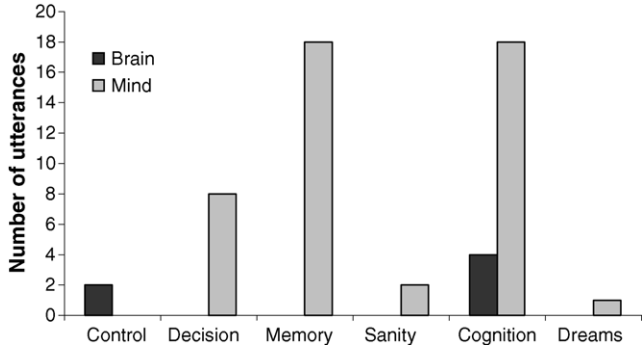

Fig. 2. Frequency of references to six mental functions for brain and mind utterances (input to children).

for decision (e.g., "make up your mind"), memory (e.g., "remind me"), and cognition (e.g., "on your mind"). In addition, mind references occurred for all other mental functions, with the exception of control. Thus, the input children receive implicates the mind in a variety of mental functions. By contrast, the only mental functions associated with the brain were control and cognition. No brain utterances referred to decision, memory or dream functions, which were frequently referenced in mind utterances.

The pattern for children's output was quite similar to the pattern for input (see Fig. 3). Children produced many more references to the mind than the brain, and most of these references concerned decision, memory, and cognition.

1.2.4. Analysis of anatomical references

Collapsing across input and output, only 1.3% (13) of mind and brain utterances contained a direct anatomical reference. Of these 13 utterances, 11 referred to the brain and 2 referred to the mind.

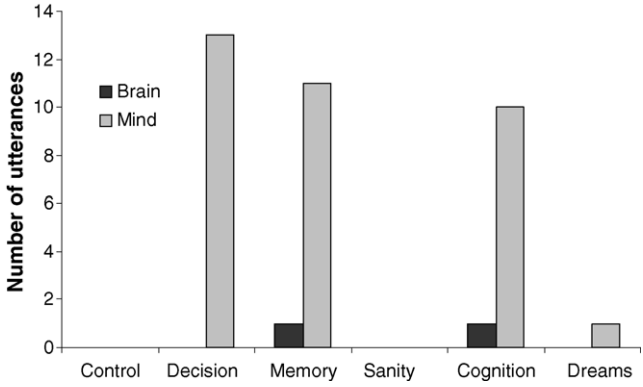

Fig. 3. Frequency of references to six mental functions for brain and mind utterances (output by children).

1.3. Discussion

To summarize the findings of Experiment 1, children heard much more testimony about the mind than the brain. In addition, as compared to brain references, a higher proportion of mind references included a reference to mental functions. These references increased with the age of the child, and focused on the mind as the locus of cognition, decision, and memory, with additional references to sanity and dreams. Input concerning the brain included no references to decision, memory, or dreams and was confined to control and cognition.

Children produced the term *mind* when referring to mental functions more frequently than the term *brain*. Moreover, their output increased with age, and fell into the same three primary categories as their input: cognition, decision, and memory. By contrast, children almost never used the term *brain* when referring to a mental function. In fact, the only child in our sample to use the term *brain* to refer to a mental function was Ross (in three utterances).

What do these findings mean for the transplant studies conducted by Johnson (1990) and Gottfried et al. (1999)? These data support our two hypotheses, namely that children receive more linguistic input about the role of the mind than the brain with respect to various mental functions, and that children themselves talk more about the mental functions of the mind than the brain. Because personal identity is strongly tied to mental functions, the results of this experiment open up the possibility that children may develop an earlier understanding of the relationship between mind and identity as compared to the relationship between brain and identity.

2. Experiment 2

In Experiment 2, we conducted a modified identity transformation study. Five- and 7-year-olds each received two stories about a magical transformation, one resulting in a mismatch between mind and body, the other resulting in a mismatch between brain and body. To check the pattern of mature judgment on the two stories, we also tested a group of adults. We expected to replicate the results of Gottfried et al. (1999) and Johnson (1990), with 5-year-olds performing at chance and 7-year-olds performing above chance on the story involving a mismatch between brain and body. Based on the findings of Experiment 1, that children receive far more input about the mind than they do about the brain, we further hypothesized that children would be more accurate in recognizing the enduring identity of this transformed creature when the transformation involved a mismatch between mind and body as compared to brain and body.

2.1. Method

2.1.1. Participants

A total of 43 children participated, 23 5-year-olds (mean: 5;6, range: 5;0–6;1), and 20 7-year-olds (mean: 7;3, range: 6;9–8;1). Children were recruited from summer programs and after-school programs in Brookline, MA, Newton, MA, and Pawtucket, RI. Children came

from a wide range of socio-economic backgrounds. The majority of children were white, although a range of ethnicities was represented. Children participated with the consent of their parent or guardian. In addition, 43 adults were tested. All adults were students of education at the postgraduate level attending Harvard University. They came from a broad range of undergraduate disciplines and educational backgrounds.

2.1.2. General procedure

Each child was taken to a quiet area by one of two experimenters (the authors K.C. and E.P.), who read the stories and questions out loud and recorded the child's responses. Adults participated in the same paradigm in a questionnaire format.

The format of the stories was similar to previous transplant studies (Gottfried et al., 1999; Johnson, 1990), with a few exceptions. In order to minimize task demands, the stories involved a single person whose external or internal characteristics were transformed, as opposed to the two-way "swap" format used in previous studies. Furthermore, the less familiar medical context was eliminated and replaced with the more familiar fairy-tale setting. Prior research suggests that such a fantasy context can serve to enhance children's encoding and analysis of story materials (Dias & Harris, 1988, 1990; Lillard & Sobel, 1999; Taylor & Carlson, 1997). These modifications were intended to facilitate overall performance in both mind and brain stories.

Each participant heard two fairy tale stories, one about the mind and one about the brain. For half the participants in each group, both stories described the magical transformation of a character's external characteristics (external transformation) whereas for the remaining participants both stories described the magical transformation of a character's internal characteristics (internal transformation). In one of the two external transformation stories, the character's mind was left unchanged despite an external, bodily transformation. In the other external transformation story, the character's brain was left unchanged despite an external, bodily transformation. The two internal transformation stories described the magical transformation of a character's mind in one story and brain in the other story—with the body left unchanged in each case. In addition, story order (mind first versus brain first) was systematically varied across participants.

Each participant heard two different story templates: one about a girl named Molly, and one about a boy named Chris. The order of these templates and the mental organ (mind/brain) to which they were applied was systematically varied. For example, the script for the external transformation, brain story for the Chris template was as follows:

> Once upon a time there was a boy named Chris. Whenever someone asked, "Who are you?" Chris always said, "I'm Chris!" One cold winter day, Chris was walking in the woods to his grandmother's house. He knew how to get there all by himself. As he was walking through the woods, he was thinking about his favorite food, ice cream. Then he ran into a wizard. The wizard looked at Chris and said "I'm going to put a spell on you! I'm going to turn your body into the body of a horse." The wizard waved his magic wand and Chris turned into a horse. His brain was still the same, but his body had turned into the body of a horse.

In the internal transformation story, Chris's body stayed the same but either his mind or his brain was transformed into that of a horse. The Molly template was highly similar to

the Chris template. In the Molly template, a fairy cast a spell on Molly, either turning her body into the body of a seal and leaving her mind or brain unchanged or turning her mind or brain into that of a seal while leaving her body unchanged.

After hearing the first fairy-tale, participants were asked three memory check questions. For example, the memory questions for the above example were:

(1) What did the wizard do to Chris?
(2) What does Chris look like now, a horse or a little boy?
(3) Whose brain does Chris have now, his or a horse's?

Participants were discarded if they did not answer the memory questions correctly ($N = 4$, one adult and three 5-year-olds).

These memory questions were followed by a series of four, two-alternative, forced choice tests questions that focused on various aspects of personal identity, namely questions regarding the name, preferences, memories, and knowledge that the transformed character would have following the transformation. A fifth and final forced choice question focused on category membership. The order of presentation of the four personal identity questions was varied randomly. Within each forced choice question the order of the two choices was randomly varied. The personal identity questions for the Chris story were as follows:

Name question: *If you asked him who he was, what would he say "I'm Chris!" or "I'm a horse"?*
Preference question: *Does he think about eating grass, or about eating ice cream?*
Memory question: *When he remembers being little, does he remember being a little boy, or being a little horse?*
Knowledge question: *Does he know the way to his grandmother's house, or does he know where to find good grass to eat?*

Following these four personal identity questions, participants were also asked about the category membership of the transformed protagonist. For example, following the Chris story, participants were asked: "*What is Chris now really, a boy or a horse?*" The order of mention of these two alternatives was also randomized.

Participants were then given a second story, followed by the memory and test questions. Finally, participants were asked a series of nine follow-up questions:

(1) What part of your body do you use to think?
(2) Do you need a brain to remember?
(3) Does a rock have a brain?
(4) Does a tree have a brain?
(5) If you could see inside someone's head, would you be able to see their brain?
(6) Do you need a mind to remember?
(7) Does a rock have a mind?
(8) Does a tree have a mind?
(9) If you could see inside someone's head, would you be able to see their mind?

Question 1 was always presented first and participants were randomly assigned to hear either the four brain questions followed by the four mind questions, or the reverse. The four brain and mind questions were presented in a randomly determined order.

2.2. Results for adults

2.2.1. Personal identity questions

For each story, adults were scored for the number of personal identity questions (maximum = 4 for each story) that they answered in terms of the mental (i.e., brain or mind) characteristics of the protagonist as opposed to his or her bodily characteristics. *T*-tests confirmed that overall adult performance was above chance for both the brain and mind story (see lower panel of Table 3). Binomial tests confirmed that adults performed significantly above chance on each of the four personal identity questions for both the mind and brain story (see Table 3). Indeed, inspection of Table 3 reveals that adults were highly consistent in their pattern of judgment across all the personal identity questions.

2.2.2. Category membership question

For the brain story, 31 of 42 adults (74%) judged category membership based on external appearance. That is, adults believed that if Molly's body were transformed into the body of a seal while her brain remained unchanged, the resultant creature was a seal. Conversely, adults judged that if Molly's brain were transformed into the brain of a seal while her body remained the same, the resultant creature was a girl. A similar pattern of performance was found in the mind story, with 30 of 41 adults (73%) basing their judgments on external,

Table 3
Experiment 2, number of participants correct (proportion correct) on four personal identity questions by age group and story type (brain vs. mind)[a]

Question	Brain	Mind
5-year-olds ($N = 20$)		
Name	9 (.45)	11 (.55)
Preference	15 (.75)*	16 (.80)*
Memory	13 (.65)	11 (.55)
Knowledge	14 (.70)	16 (.80)*
Mean total (out of 4)	2.55 (.64)	2.70 (.68)*
7-year-olds ($N = 20$)		
Name	14 (.70)	18 (.90)***
Preference	17 (.85)**	19 (.95)***
Memory	18 (.90)***	18 (.90)***
Knowledge	18 (.90)***	18 (.90)***
Mean total (out of 4)	3.35 (.84)***	3.65 (.91)***
Adults ($N = 42$)		
Name	40 (.95)***	41 (.98)***
Preference	41 (.98)***	41 (.98)***
Memory	40 (.95)***	40 (.95)***
Knowledge	40 (.95)***	40 (.95)***
Mean total (out of 4)	3.83 (.96)***	3.86 (.97)***

[a] Significance level markers represent results significantly different from chance. *T*-tests were used to compare mean totals to chance. All other comparisons were made using binomial tests.

* $p < .05$.
** $p < .01$.
*** $p < .001$.

bodily characteristics (one adult failed to answer this question). Binomial tests confirmed that adult performance differed significantly from chance ($p < .01$) for both stories.

2.2.3. Follow-up questions

Due to ambiguous formatting of the written questionnaire, only 24 of the 42 adults responded to the initial open-ended question (*What part of your body do you use to think?*). Of these 24 adults, 20 (83%) concurred that the brain is the part of the body used to think. Only two adults (8%) claimed that the mind is the body part used to think, and an additional two adults (8%) attributed thought to both the mind and brain. The lower panel of Table 6 shows the performance of the 40 adults who completed the remaining follow-up questions. Adults were above chance in judging that one needs a mind/brain to remember, that rocks and trees do not have a minds/brain, that the brain is visible, and that the mind is invisible.

In summary, when adults were posed personal identity questions (relating to the name, memories, knowledge, and preferences of the transformed character), they tied these identity-related characteristics to the brain or mind of the transformed character, as opposed to his or her bodily characteristics. However, when they were asked to assess category membership, adults' replies were more divided. A significant majority judged category membership in terms of the bodily characteristics of the transformed character, whereas a minority focused on his or her brain or mind. Finally, most adults claimed that a brain and a mind are needed to remember and that the brain is visible, but the mind is not.

2.3. Results for children

2.3.1. Personal identity questions

For each story, children, like adults, were scored for the number of personal identity questions (maximum = 4 for each story) that they answered in terms of the mental characteristics of the protagonist as opposed to his or her bodily characteristics. Based on previous findings, we anticipated that no significant gender differences would emerge. We also anticipated that there would be no effect of story order (mind first or brain first), transformation type (internal or external) or protagonist (Molly or Chris). To check these expectations, data were entered into a preliminary four-way ANOVA, with gender, story order, and transformation type as between-subjects factors, and protagonist (Molly or Chris) as a within-subjects factor. No significant main effects or interactions were found. Accordingly, in subsequent analyses, data were collapsed across gender, story order, transformation type, and protagonist.

Next, we conducted a two-way ANOVA with age group (5, 7) as a between-subjects variable and story type (mind, brain) as a within-subjects factor. A main effect of age was found, $F(1,38) = 6.01$, $p < .05$, with 7-year-olds performing more accurately than 5-year-olds. A main effect of story type was also found, $F(1,38) = 5.22$, $p < .05$, with children performing more accurately on the mind story than the brain story.

Table 3 shows the total number of correct responses (and the proportion of correct responses) on each of the four personal identity questions as a function of age group and story type (mind versus brain). *T*-tests were used to compare overall performance on the four questions to chance and binomial tests were used to compare performance on each question

Table 4
Number of children scoring 0–4 correct on personal identity questions as a function of age and story type (brain vs. mind)

	0	1	2	3	4	*N*
5-year-olds						
Brain	2	4	2	5	7	20
Mind	2	3	1	7	7	20
7-year-olds						
Brain	0	1	3	4	12	20
Mind	0	1	1	2	16	20

to chance (see Table 3). Five-year-olds' overall performance did not differ significantly from chance for the brain story, but their overall performance was significantly above chance for the mind story. Seven-year-olds' overall performance was above chance for both the brain and the mind story. Turning to performance on individual questions, 5-year-olds performed above chance on the knowledge and preference questions in the mind story but on only the preference question in the brain story. Seven-year-olds performed significantly above chance on all four questions in the mind story and all but one question (name question) in the brain story.

In order to assess the consistency of children's replies, the number of children scoring 0–4 correct is shown in Table 4 as a function of age and story type. In the 5-year-old group, seven children were consistently correct on all four questions in the brain story and seven children were correct on all four questions in the mind story. In the 7-year-old group, 12 children were correct on all four questions in the brain story, but 16 children were correct on all four questions in the mind story.

To assess the extent to which children performed consistently across the mind and brain tasks, we divided the children into two groups: those who performed consistently on the four questions in the mind story (score = 4) and those who performed inconsistently on those questions (scores < 4). We then categorized these children in terms of their performance on the brain story (using the same categories for consistent and inconsistent performance). The resulting distribution of performance is displayed in Table 5. For the most part, children performed similarly across stories. That is, children who performed consistently in the mind story also performed consistently in the brain story whereas children with inconsistent scores in the mind story also had inconsistent scores in the brain story. Nevertheless, five children had consistent scores on the mind story but inconsistent scores on the brain story, whereas only one child had consistent scores on the brain story but inconsistent scores on the mind story.

Table 5
Number of children showing consistent and inconsistent patterns of performance across the mind and brain stories

	Brain score < 4	Brain score = 4
Mind score < 4	16	1
Mind score = 4	5	18

2.3.2. Category membership question

Recall that adults did not display a strong consensus in their replies to the category membership question. Most adults claimed that category membership depended on the overall bodily characteristics of the protagonist rather than his or her mind or brain. Thus, when Chris was given the body of a horse, they judged that he had become a horse even though his mind (or brain) remained unchanged. Conversely, when Chris's body remained unchanged but his mind or brain was magically transformed to that of a horse, most adults insisted that Chris remained a boy. Nevertheless, a minority of adults drew the opposite conclusion and judged that the identity of the mind or brain was critical for category membership. For the brain story, the majority of 5- and 7-year-olds (13 out of 20 in each case) produced an adult-like response by focusing on bodily characteristics, but binomial tests showed their performance was not significantly above chance ($p = .263$) in either case. For the mind story, a non-significant minority of 7-year-olds (8 out of 20; $p = .503$) but a significant majority of 5-year-olds (15 out of 20; $p < .05$) judged category membership in terms of bodily characteristics.

2.3.3. Follow-up questions

When asked which part of the body they used to think, 29 children (72.5%) named the brain, whereas only two children (5%) named the mind. Additionally, six children (15%) gave the response "head," and three children (7.5%) gave another answer (e.g., "belly"). Response patterns for this question were similar across the two age groups. Table 6 shows children's responses on the remaining follow-up questions. Children's responses on these questions were similar to those of adults. Thus, almost all children in

Table 6
Number of participants answering "yes" on follow-up questions by age group and story type (brain vs. mind)[a]

Question	Brain	Mind
5-year-olds ($N = 20$)		
Need brain/mind to remember	20 (1.0)***	17 (.85)**
Rock has a brain/mind	0 (0)***	2 (.1)***
Tree has brain/mind	1 (.05)***	2 (.1)***
Brain/mind visible	11 (.55)	7 (.35)
7-year-olds ($N = 20$)		
Need brain/mind to remember	17 (.85)**	19 (.95)***
Rock has a brain/mind	0 (0)***	0 (0)***
Tree has brain/mind	1 (.05)***	2 (.1)***
Brain/mind visible	15 (.75)*	10 (.50)
Adults ($N = 40$)		
Need brain/mind to remember	37 (.93)***	36 (.90)***
Rock has a brain/mind	0 (0)***	2 (.05)***
Tree has brain/mind	2 (.05)***	4 (.10)***
Brain/mind visible	39 (.98)***	6 (.15)***

[a] Significance level markers represent results significantly different from chance as measured by binomial tests.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

each age group claimed that both the brain and the mind are needed for remembering. In addition, most children in each age group correctly denied that trees and rocks have brains or minds. Children were less unanimous in their judgments regarding the visibility of the brain and mind. Nevertheless, a McNemar test confirmed that children were more likely to claim that the brain but not the mind is visible than the reverse ($\chi^2(1,40) = 4.27$, $p < .05$).

3. Discussion

In the introduction, we noted the long-standing philosophical claim that the stability of our personal identity over time depends on the continuity of our mental functioning—the fact that we retain various individualized memories, beliefs, and preferences, despite marked changes in our bodily characteristics over the course of a lifetime. We also drew attention to traditional stories in which the mind of the protagonist remains unchanged despite a sudden and radical transformation of his or her bodily characteristics. Based on these observations, we hypothesized that children come to think of the mind as the seat of an individual's stable identity before they treat the brain as such. We further proposed that everyday talk about mental functioning implicates the mind more often than the brain and that such talk would assist children in linking personal identity to the mind.

Experiment 1 provided support for our proposal concerning everyday talk about mental functioning. Children heard more talk about the mind than the brain with respect to various mental functions. In addition, children themselves talked more about the mental functions of the mind than the brain. Experiment 2 examined children's understanding of the continuity of mental functioning more directly. Children were presented with magical transformations that resulted in a mismatch either between mind and body or between brain and body. Children were asked to say whether identity-related functions (the protagonist's professed name, preferences, memories, and knowledge) would be linked to the bodily characteristics of the protagonist or to his or her mental characteristics. Children were more accurate in answering these personal identity questions for the mind story than the brain story. Thus, children were more likely to display the adult response pattern when the story involved a mind–body mismatch as opposed to a brain–body mismatch. Indeed, for the brain story, our results were similar to those of Gottfried et al. (1999) and Johnson (1990). Five-year-olds' overall performance was at chance on the four identity questions, whereas 7-year-olds' performance was above chance.

Based on the results of Experiment 1, we expected that children might find it easier to localize identity to the mind and later extend this understanding to the brain. Thus, we anticipated that 5-year-olds might perform above chance on the mind story while performing at chance on the brain story. The results support this expectation. Five-year-olds' overall performance on the four identity questions was significantly above chance on the mind story despite their being at chance on the brain story. A similar trend toward superior performance on the mind as compared to the brain story emerged when we examined the consistency of children's performance. Five children were consistently correct on the mind-identity questions but not on the brain-identity questions, whereas only one child displayed the inverse pattern of performance.

Although our results might be taken to suggest that 5-year-olds' understanding of the connection between identity and mental processes was masked in previous studies by the use of the relatively unfamiliar word *brain*, it is important to note that that 5-year-olds' level of understanding is not equivalent to that of 7-year-olds, even when the word *mind* is used. Five-year-olds' overall performance on the identity questions was poorer than that of the 7-year-olds, irrespective of story type. Thus, even if children have a better understanding of the relationship between the mind and identity than the relationship between the brain and identity, children's overall understanding of these relationships continues to develop between the ages of 5 and 7.

Examination of 5- and 7-year-olds' performance on the individual test questions provides further insight into the development of identity concepts between the ages of 5 and 7. Five-year-olds were above chance on the knowledge and preference question in the mind story and on only the preference question in the brain story. In contrast, 7-year-olds were above chance on all four personal identity questions in the mind story and on all but the name question in the brain story. Taken together, the findings from the two age groups and the different questions suggest that children's understanding of the mental basis of personal identity emerges gradually over this time period. At first, children grasp the role of the mind in the retention of individualized preferences and knowledge. Eventually, they grasp the role of the brain in the retention of individualized memories, as well as preferences and knowledge.

Turning to respondents' replies to the category membership question, most adults made judgments based on the body rather than on mental functioning. For example, they judged that a protagonist with the mind (or brain) of a boy but the body of a horse is a horse. Thus, responses to the category membership question departed dramatically from the pattern displayed for the personal identity questions where, as noted above, adults focused on the mental functioning of the protagonist. This contrast is particularly striking if we consider how adults responded to the name question. When asked who Chris would claim to be if his mind (or brain) remained the same but he had a horse's body, almost all adults judged that he would say that he was Chris rather than a horse.

Why do adults answer the personal identity questions and the category membership question differently? The most plausible interpretation is that they adopt distinct—and ultimately irreconcilable frames of reference—in answering the two questions. The category membership question invites respondents to judge the protagonist's natural, biological kind. When assessed with that question in mind, the protagonist displays almost all of the characteristics of a horse. Thus, to paraphrase the passage from the Odyssey, he would have the head, voice, coat, and shape of a horse—even if his mind or brain were unchanged. By contrast, the name question invites respondents to consider the quandary facing Chris from his perspective and to assess the identity that he will claim for himself. Insofar as his mind remains the same, including his memories, knowledge, and preferences, he will likely claim to be a boy, namely Chris, despite now having the body of a horse.

To what extent did children display the same pattern as adults on the category membership question? With the exception of 5-year-olds in the mind story (who did judge in a similar fashion to adults) children failed to answer the category membership question systematically—although for the brain story a non-significant majority of children in both age groups did display the adult pattern. One possible explanation for this pattern of results

is that children were less flexible than adults in switching frameworks—in switching from the protagonist's perspective to an assessment of the protagonist's natural kind. Recall that respondents answered all four personal identity questions before being finally asked the category membership question. Arguably, the series of personal identity questions prompted children to focus on the internal mental life of the transformed protagonist to the neglect of his or her bodily characteristics. If children approached the category membership question with that bias it would reduce the likelihood of their displaying the adult focus on bodily characteristics. Indeed, a minority of adults may have been susceptible to the same bias. Recall that adults were highly systematic in focusing on mental functioning when answering the four personal identity questions—only one or two (out of 42) ever focused on bodily characteristics. By contrast, their answers to the category membership question were less consensual. Approximately, one quarter deviated from the majority pattern and answered in terms of mental functioning. To the extent that this perseverative bias did occur, children's unsystematic performance on the category membership question should be viewed with caution. If children were questioned about category membership in isolation—rather than following a series of personal identity questions—they might resemble the adult pattern of judgment more closely.

Turning to the follow-up questions, most children and adults volunteered that the brain is the body part used for thinking and claimed that neither a rock nor a tree has a brain or mind. Children and adults were also more likely to assert that the brain is visible than that the mind is visible. However, a surprising number of children denied the visibility of the brain or asserted the visibility of the mind. Thus, by the age of 7, children's understanding of the material properties of the brain and the non-material properties of the mind is still developing.

The most important finding to emerge from the follow-up question is the pattern displayed on the remember question. Five-year-olds, 7-year-olds, and adults claimed that one needs a brain to remember and also that one needs a mind to remember. This early appreciation of the essential role of the brain and mind in cognitive activities such as remembering, replicates the earlier findings of Johnson and Wellman (1982). The systematic performance of the 5-year-olds on the follow-up memory question is particularly noteworthy when compared to their performance on the memory question concerning personal identity. Recall that when 5-year-olds were asked what particular memories the protagonist would have (e.g., "Does he remember being a little boy or a horse?") they did not answer systematically in terms of the mental characteristics of the protagonist. A plausible implication of this pattern of findings is that children's understanding of the role of mental functioning in personal identity progresses through two phases. At first, they understand that mental functioning calls for a mental organ, such as the mind or the brain. Initially, however, they construe that organ as being necessary for activating or energizing mental activities—much like a battery or an engine (Gottfried et al., 1999). Only later do they come to think of that organ as having an individual profile so that, for example, when Chris has the same mind as before, it is not just that he can still remember, he will also retrieve the same personalized memories as before.

In conclusion, our findings confirm that young children receive more linguistic information about the role of the mind in mental functioning than the role of the brain. That differential input is reflected in children's own output. Children speak more about the mind

than the brain and they are more likely to discuss the role of the mind than the brain in mental functions that are important for personal identity, notably thinking and remembering. When asked more directly about the properties that determine personal identity, children showed a broad resemblance to the pattern displayed by almost all adults: they often judged that a protagonist who had undergone a magical transformation resulting in a mind–body mismatch or a brain–body mismatch would have the individual memories, knowledge, preferences, and professed identity associated with the individual mind or brain of the protagonist as opposed to his or her body. However, within this broad resemblance, children's overall performance on the personal identity questions varied with age and the type of transformation. Not surprisingly, 7-year-olds were more accurate than 5-year-olds. In addition, and consistent with the pattern of findings from Experiment 1, children were more accurate when the transformation involved a mind–body mismatch rather than a brain–body mismatch. By implication, even 5-year-olds might have some insight into the predicament facing Odysseus' men.

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