Identifying and counting objects: The role of sortal concepts

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A B S T R A C T
Sortal terms, such as table or horse, are nouns akin to basic-level terms. According to some theories, the meaning of sortals provides conditions for telling objects apart (individuating objects, e.g., telling one table from a second) and for identifying objects over time (e.g., determining that a particular table at one time is the same table at another). A number of psychologists have proposed that sortal concepts likewise provide psychologically real conditions for individuating and identifying things. However, this paper reports five experiments that cast doubt on these psychological claims. Experiments 1–3 suggest that sortal concepts do not determine when an object ceases to exist and therefore do not decide when the object can no longer be identical to a later one. Experiments 4–5 similarly suggest that sortal concepts do not provide determinate conditions for individuating objects. For example, they do not always decide whether a room contains one table or two. All five experiments feature ordinary objects undergoing ordinary changes.

1. Introduction

Just as people have general concepts of categories of things, people also have singular concepts of individual members of those categories. That is, just as we have cognitive representations of (the categories of) dogs and people in general, we also have cognitive representations of Fido and Uncle Andy in particular.

To see the importance of singular concepts, consider that we are successfully able to identify and individuate objects that persist over long periods. For instance, even if we have neither seen nor heard from Uncle Andy since last Christmas, and even if since then he has grown a beard and lost some weight, we have the resources to judge correctly that Uncle Andy is the same individual that we saw at the end of last December. And even if Uncle Andy is standing amongst other similar looking individuals, we have the resources to establish that he is just one of the many distinct men in the group.

But how is this possible? What is it about our concept of Uncle Andy that allows us to successfully identify him over time and distinguish him from other people? More generally:

Question 1: Assuming that we have a singular concept, C, of an individual, S, at a time, \( t_1 \), how do we determine whether S continues to exist at a later time, \( t_2 \)?

Question 2: Assuming that we have a singular concept, \( C \), of an individual, \( S \), at a time, \( t_1 \), how do we individuate \( S \) from other individuals at \( t_1 \)?

A number of developmental psychologists have recently made a valiant attempt to answer these questions (e.g., Carey, 2001; Carey & Xu, 1999; Macnamara, 1986; Prasada, Ferenz, & Haskell, 2002; Rhemtulla & Xu, 2007; Xu, 1997, 2005, 2007; Xu & Carey, 1996), drawing on earlier theories in philosophy (e.g., Dummett, 1981; Gupta, 1980; Hirsch, 1982; Strawson, 1959; Wiggins, 2001). According to this approach, we have sortal concepts that specify the criteria for individuating and identifying their instances. Sortal concepts are ones like PERSON, CHAIR, or TREE that provide a fundamental answer to the questions \( \text{What is it?} \) and \( \text{How many are there?} \) for individuals (Wiggins, 2001). Sortal theories maintain, for example, that by possessing the sortal concept PERSON, we thereby come to possess certain criteria for individuating and identifying Uncle Andy (see Section 1.1 for more on what these criteria amount to). Although the notion of a sortal concept derives from philosophical theories, sortals have a close counterpart in basic-level concepts in psychology, since experiments have shown that people overwhelmingly use basic-level terms to answer the \( \text{What is it?} \) question (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976).

The aim of this paper is to examine the role that sortal concepts play in human cognition and to argue that, contra the psychological theories just cited, sortal concepts do not furnish identity or individuation conditions; that is, sortal concepts fail to provide the correct answer to either Question 1 or 2. The plan is as follows. In the rest of this section, we highlight what we take to be the most

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1 It is important to keep in mind that Question 1 is a question about numerical and not qualitative identity or similarity. The issue is whether the very same individual (Uncle Andy, say) continues to exist, and not whether someone similar exists who shares his properties. We will follow tradition in assuming that numerical identity is a relation that is reflexive (i.e., \( x = x \)), symmetrical (i.e., if \( x = y \), then \( y = x \)), and transitive (i.e., if \( x = y \), and if \( y = z \), then \( x = z \)).

2 Henceforth we will use all capitals (e.g., PERSON) when denoting a concept.
important features of sortal theories, focusing mainly on their advantages. In Sections 2–4, we present three experiments that suggest that sortal concepts cannot explain how we identify individuals over time. Then, in Sections 5 and 6, we present two experiments that suggest that sortal concepts cannot explain how we individuate objects either. Finally, we conclude in Section 7 by highlighting some of the advantages and disadvantages of psychological sortals.

1.1. Psychosortalism: A brief overview

We use the term psychosortalism to name the thesis that people have sortal concepts (mental representations) that specify the criteria for individuating and identifying their instances. Psychosortalists are those who hold this thesis, including the developmental psychologists we mentioned earlier. It is worth noting that although psychosortalism draws from sortal theories in philosophy, the two views are importantly different. The former is a psychological thesis whereas the latter is a metaphysical one. The psychological thesis is our present concern. How the metaphysical and the psychological sortal theories interrelate is an important question, and we return to it in the General Discussion. The same goes for the cognate issue of sortal theories’ status as normative or descriptive.3

Now, what are sortal concepts and how exactly does possessing one provide us with answers to Questions 1 and 2? According to psychosortalists, sortal concepts are cognitive representations associated with sortal terms, and with respect to Questions 1 and 2, the relevant sortal terms are themselves count nouns that denote specific categories of things.4 For example, person and computer are sortal terms, allowing people to count how many people and how many computers there are. By contrast, predicates like red and wooden are not sortal terms because we cannot count how many red or how many wooden there are.

The meanings of sortal terms are said to provide sortal-specific criteria for identifying and individuating entities. For instance, when we are looking at a room full of people and computers, the criteria for individuation provided by PERSON and COMPUTER specify how to count the number of people and computers respectively. And the rules for identification provided by COMPUTER and PERSON specify the conditions under which computers and people continue to exist. For instance, the sortal concept COMPUTER might specify that the same laptop can persist through the process of being completely disassembled and reassembled, whereas the sortal concept PERSON might specify that Uncle Andy cannot persist after being completely dismembered. Thus, in virtue of being associated with a sortal concept, a sortal term is said to furnish the identity and individuation conditions for the individuals to which that concept applies.

More specifically, psychosortalism says that sortal concepts furnish identity conditions in the sense that:

**Principle 1:** If a subject, H, judges that an individual, O1, at a time, t1, belongs to a sortal category, S, then H will judge O2 at a later time, t2, as being identical to O1 (i.e., O1 = O2) only if H judges that O2 belongs to S.

The idea here is that our sortal concepts tell us what sorts of changes individuals can undergo. If we recognize that an individual has undergone a change that is incompatible with its sortal, then we will judge that it no longer exists. For example, we judge that a specific person (say, Uncle Andy) at one time is identical to an individual at a later time only if we judge that the individual is also a person.6 As Xu (2007, p. 401) puts it:

Sortal information includes generalizations such as objects do not change kind membership; if an object seen at time 1 falls under one sortal concept and an object seen at time 2 falls under another sortal concept, then they must be two objects.

And Rheinlanta and Hall (2009, p. 292) claim that, according to psychosortalism:

… in order for a cat seen at one time to be judged to be the same individual as one seen later, the later object must also be a cat.

Psychosortalism also says that sortal concepts furnish individuation conditions in the sense that:

**Principle 2:** If H possesses a sortal concept, S, of some category, C, then H will be able to individuate members of C in virtue of possessing S.

Principle 2 says that the sortal information provided by shirt says, specifies how to count shirts and that, consequently, by possessing the SHIRT concept we are thereby able to individuate the shirts in a given closet. Thus, Xu (1997, p. 365) claims that sortal concepts

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3 Some psychosortalists distinguish between sortal principles of individuation and identity, which are taken to be metaphysical matters, and criteria of individuation and identity, which are taken to be conditions that people apply in individuating and identifying things (Macnamara, 1986). In keeping with our emphasis on psychology, however, we will use sortal criteria to mean specific conditions that people use for individuating and identifying objects, and sortal principles to be be generalizations governing the way people apply these criteria (see Principles 1 and 2 later in this section).

4 Two related points are worth noting here. First, philosophical theories differ in whether they allow terms other than count nouns to be sortals. According to some theories (e.g., Hirsch, 1982; Strawson, 1959), sortals are fundamentally tied to distinguishing and counting individuals. Hence, most mass nouns, such as blood, air, or sand, which do not allow counting, cannot be sortals (e.g., one cannot count five bloods). However, other philosophers (e.g., Gupta, 1980) and psychologists (e.g., Macnamara, 1986) take mass nouns to be sortals, on the grounds that these terms make it possible to identify particular substances over time (e.g., to determine whether the blood in the test tube today is the same as the blood that was in the tube yesterday). In this paper, we restrict our attention to count sorts. This is because we are interested here only in how people identify and individuate physical objects named by count nouns, such as person and computer. We remain neutral on the question of whether mass nouns can also be sortals. For further issues concerning the varied definitions of “sortal,” see Feldman (1973) and Grady (2014). Second, by definition, any count noun (e.g., table) can be used in noun phrases with numeric quantifiers (e.g., three tables). The grammatical status of table as a count noun is something that everyone (psychosortalists and non-psychosortalists alike) can agree to. However, if sortal concepts are going to earn their keep by playing an important and distinctive role in human cognition, psychosortalism must show how sortal concepts are more than just concepts of categories of things referred to by count nouns. The psychosortalist must also show that these concepts furnish identity and individuation conditions in the sense specified by Principle 1 and Principle 2 (or some similar formulation). For this reason, the burden cannot be met, then there does not seem to be any good reason to countenance the existence of sortal concepts (see Goodman, 2012, for more on this point). As we are about to see, psychosortalists do indeed claim to be explaining object individuation and identity. From this point of view, count nouns like quantity and proportion are not sortals, since they do not individuate their referents. Although three quantities is grammatical, the concept QUANTITY does not provide conditions for distinguishing one quantity (e.g., of water) from another. It is unclear, for example, how many quantities of water exist in a pond. Individuation of particular quantities must come from other contextual sources (see Rips & Hsepou, 2015).

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5 See Lowe (1989a, 1989b) and Blok, Newman, and Rips (2007) for more on these sortal principles. Additional principles would be needed to provide criteria that are both necessary and sufficient for identity.

6 Principle 1 does not say that sortal concepts allow us to re-identify objects under any circumstances whatsoever. For instance, suppose there are two qualitatively identical cups, and that both are dropped on the ground such that they shatter and their pieces are mixed together. Principle 1 does not say that by possessing the CUP sortal we will necessarily be able to re-identify these cups. Rather, Principle 1 just says that if people judge that an object, O1, is identical to an object, O2, at a later time, then those people will judge that O1 and O2 belong to the same sortal category.
Rather, our aim is just to establish that Principle 1 is false by exhibiting the objects belong to the same category (e.g., they are both shirts). If an object at one time is identical to an object at another time, then objects. Of course, people often think that if an object at one time...complained with: Should a red shirt be counted as one or should the shirt, the two sleeves, and two pockets be counted separately so that we have five reds? In contrast, a request to “count the red shirts in this room” will receive a definite answer: a red shirt (with its sleeves and pockets) should be counted as one shirt, not two. Hence, the count noun “shirt” gives us the principles for what to count as one shirt whereas the adjective “red” does not provide principles of counting.

And Carey (1995, p. 108) puts the point this way:

To see the logical role sortals play in our thought, first consider that we cannot simply count what is in this room. Before we begin counting, we must be told what to count. We must supply a sortal...

It is in this sense, then, that psychosortalism purports to provide answers to Questions 1 and 2.

Of course, psychosortalists need not maintain that possessing a sortal concept itself, absent other background information (e.g., spatio-temporal cues), is sufficient for individuating objects. We may understand in theory how to individuate shirts in virtue of having the sortal concept SHIRT and yet be unable to count the shirts in a drawer if, for example, lighting conditions are poor. The same is true for identifying objects over time. That is, psychosortalists don’t claim that simply being told that Uncle Andy is a person, without any further information, would allow us to trace his identity. Rather, according to psychosortalists, by knowing that Uncle Andy is a person, we learn what information we need (in principle) for tracing his identity. That information may specify, for example, continuity of his mental or bodily states. Moreover – and this is the key – this information will be sortal-specific; it will differ for a person and for a cup, for example.

1.2. Psychosortalism and object identification

There is a growing body of research that suggests that sortal concepts furnish the identity conditions for individual objects (e.g., Bonatti, Frot, Zangl, & Mehler, 2002; Carey & Xu, 1999; Macnamara, 1986; Macnamara & Reyes, 1994; Xu, 1997, 1999, 2005, 2007; Xu & Carey, 1996; Xu, Carey, & Quint, 2004). In Sections 2–4, we present experiments that suggest otherwise. The basic idea is to argue that people’s judgments about the transformations of objects (e.g., Blok, Newman, & Rips, 2005; Hall, 1998; Johnson, 1990; Liittschwager, 1995; Nichols & Bruno, 2010; Rheinlullla & Hall, 2009; Rips, Blok, & Newman, 2006) show that Principle 1 is false and that, consequently, psychosoralism cannot provide an adequate answer to Question 1. Our aim is not to argue that people never satisfy Principle 1 when making judgments about the identity of individual objects. Of course, people often think that if an object at one time (e.g., a particular shirt) is identical to an object at another time, then the objects belong to the same category (e.g., they are both shirts). Rather, our aim is just to establish that Principle 1 is false by exhibiting a variety of counterexamples in which people do believe that an individual object can persist across a change in its sortal category.

In Blok et al. (2005), for example, participants report stories about a person, Jim, who underwent brain transplant surgery as the result of being in a severe traffic accident. In some of the trials, participants read that Jim’s brain was transplanted into a human body that the scientists had grown for purposes like these, and in other trials, participants read that Jim’s brain was transplanted into a robot body. Finally, participants read that either Jim’s memories remained intact after the brain transplant or else they did not. Blok et al. found that participants were likely to indicate that the post-op patient was still Jim, but only when his memories were intact. That is, regardless of whether Jim’s brain was transplanted into a human or a robot body, so long as the memories were still intact, participants judged that the post-op patient was Jim. Furthermore, participants were not likely to indicate that the post-op patient was still a person when the brain was transplanted into a robot body. In this condition (memories intact but embodied in a robot), participants were more likely to judge the post-op patient to be Jim than to be a person. What these experiments suggest is that participants conceive of individuals as being able to survive their sortals: Participants conceive of Jim as remaining the same individual even after they judge that he is no longer a member of the person category. Thus, it seems that participants violate Principle 1 when making judgments about an individual’s identity.

Psychosortalists, however, have two responses to transformation cases like these. First, Rheinlullla and Xu (2007) and Scholl (2007) have questioned whether such science-fictional transformations really get at how we conceive of individuals, or whether, instead, our judgments about these cases are simply the result of entering a sort of pretense in order to make sense of the scenarios. For instance, Rheinlullla and Xu (2007, p. 1091) remark that:

In countless stories, the prince turns into a frog or a beast, Cinderella’s pumpkin turns into a coach, Gregor Samsa turns into a beetle, the Little Mermaid turns into sea foam, and one happily comprehends all of this…One does not at all have the intuition that some of these stories are more believable than others or that some preserve identity whereas others do not. The stories simply stipulate that identity is preserved, and one believes it in the context of those fictions. This intuition leads us to suspect that identity judgments that do not correspond to real-world events are highly susceptible to the context of fiction.

And Scholl (2007, p. 579) has put the point this way:

I suspect that such studies, rather than telling us anything about underlying mental mechanisms, may instead often tell us more about how subjects respond to bizarre questions and scenarios...

Second, in previous transformation cases, the transformed individuals only persisted across a change in basic-level sortal categories—for example, from a person to a robot. However, some psychosortalists (e.g., Xu, 1997) maintain that we have a superordinate sortal concept, PHYSICAL OBJECT, in addition to basic-level sortal concepts like PERSON and COMPUTER. Following Spelke (1990), psychosortalists take a physical object (sometimes called a Spelke object) to be a bounded, coherent, three-dimensional physical entity that moves as a whole along a spatiotemporally continuous path. Hence, for the psychosortalist, PHYSICAL OBJECT is taken to be a mental representation of physical objects understood in this way. (However, see Ayers, 1997; Goodman, 2012; Hirsch, 1997; Wiggins, 1997, for philosophical objections to the PHYSICAL OBJECT sortal.)

To see the upshot of distinguishing between basic-level and superordinate sortal concepts, consider the following car-crusher...
example from Hirsch (1982): Our sortal concept CAR allows us to identify and individuate a particular car at the junkyard. As the car is being crushed, there is some point at which we conceive of the car (as such) as going out of existence and being replaced by a heap of metal and other material. However, as Xu (1997, p. 385) puts it:

...intuitively we think something has persisted through this process because we can point to the pile of metal and plastic and say, “That used to be a car.” The demonstrative “that” requires a reference that persisted through the changes: physical object appears to be a good candidate.

The psychosortalist’s point is that in addition to the basic-level CAR sortal, we also need to invoke our PHYSICAL OBJECT sortal, since the latter is the underlying concept that allows us to make sense of these types of radical transformations. Hence, psychosortalists can respond to previous transformation cases by giving the same analysis that they give to Hirsch’s car-crusher example. For instance, although people do judge that Jim can persist across a change in the basic-level person sortal, nothing about the current evidence suggests that people are not employing their physical object sortal to make sense of how he can survive as a robot (see Xu, 1997, for this line of thought). Thus, unless it can be shown that people also conceive of individuals as being able to persist across a change in the physical object sortal, these transformation cases do not completely rule out Principle 1.

The aim of the experiments in Sections 2.4 is to test people’s judgments about transformation situations that: (a) correspond to real world events (thus avoiding the first objection to previous transformation experiments), and (b) involve individuals that undergo transformations across both their basic-level sortal category as well as the superordinate physical-object category (thus avoiding the second objection to previous transformation cases).

2. Experiment 1: The transformation of artifacts and natural kinds

This experiment tests whether participants conceive of six different types of artifacts and six different types of non-human natural kinds as being able to survive a transformation across both their basic- and superordinate-level sortal categories. For instance, participants are asked to read a story about an individual cup, Sippy, that shattered after being dropped. Participants are then asked to decide whether Sippy is still a cup and whether it still exists.

All of the trials in the artifacts condition involve artifacts that shattered after being dropped from a high place. Half of the trials in the natural-kind condition involve individual pieces of fruit that were turned into fruit juice. For example, participants read a story about an individual carrot that was put through a juicer. The other half of the trials in the natural-kind condition involve individual plants that were turned into a pile of plant pieces. For example, participants read a story about an individual tree that was turned into wood chips after being put into a chipper. Table 1 provides the story and questions about the cup as an example.

Psychosortalists should predict the following: First, if people use the CUP sortal to make judgments about the identity of Sippy, and if they believe that Sippy is no longer a cup after it is dropped, then they should not judge that Sippy still exists (since this would be to conceive of Sippy as persisting across a change in the CUP sortal, which would violate Principle 1). Second, since people do not conceive of things like piles of cup pieces as being physical objects (e.g., Carey, 2001; Huntley-Fenner, Carey, & Solimando, 2002), if people use the PHYSICAL OBJECT sortal to make identity judgments about Sippy, and if they believe that after the cup is dropped Sippy is a pile of cup pieces, then they should not judge that Sippy still exists (since this would be to conceive of Sippy as being able to survive its PHYSICAL OBJECT sortal, which would also violate Principle 1).

2.1. Method

A within-subject design was used here. Twelve scenarios like the one in Table 1 were presented to participants. Each scenario described a common object (e.g., a cup) and specified its basic-level sortal term (e.g., cup) and its proper name (e.g., Sippy). Six scenarios involved different artifacts (a cup, hammer, ball, desk, chair, and sewing machine) and six involved different non-human natural kinds (a tree, leaf, pineapple, bush, carrot, and apple). Since sortal concepts correspond to basic-level terms, we stuck to terms that are typically recognized as referring to basic level categories (e.g., Markman & Wiserwski, 1997; Murphy, 2002; Rosch, 1978). The same is true of the stimuli in the experiments that follow.

For each scenario, participants indicated whether after the transformation has occurred the individual is still a member of its original sortal category (e.g., Question 2 in Table 1) and whether it still exists (e.g., Question 3). Participants were also asked a comprehension question for which the answer was clearly stated in the scenario (Question 1). This was done to screen out participants who were not reading carefully, but no participant answered these questions incorrectly.

Each scenario was presented on its own page, along with the three corresponding questions. The twelve pages were put into a booklet in a random order for each participant.

Twenty-five students from Northwestern University participated in this experiment for course credit in an introductory psychology class. They proceeded at their own pace, but finished the task in approximately 10 min. The sample sizes for this study and the following ones were selected informally prior to the experiments, based on those of earlier experiments of this type (e.g., Blok et al., 2005; Rips et al., 2006). For this and the following experiments, we have reported all measures, conditions, and data exclusions.

2.2. Results and discussion

Participants paid very little attention to either the basic-level sortals or the superordinate PHYSICAL-OBJECT sortal when making judgments about whether the artifacts and natural kinds survived. Participants decided on each trial whether an individual survived a transformation into a pile of pieces or into a portion of juice. Because portions and pieces are not physical objects in the intended sense (Carey, 2001; Huntley-Fenner et al., 2002), the transformation turned a physical object into a non-object. So if PHYSICAL OBJECT is the relevant sortal for transformations of this type, the original individual should no longer exist after the transformation, according to sortal Principle 1. However, participants decided that the items continued to exist in 90.7% of responses. For example, they believed that Sippy still exists as a pile of pieces in the Table 1 scenario.

Participants also decided on each trial whether the individual remained a member of its basic-level category after the transformation. For example, they judged whether Sippy was still a cup after shattering in the story in Table 1. If the basic-level concept (e.g., CUP) is the relevant sortal for transformations of this kind, then participants should not agree that both (a) the individual still exists but (b) is no longer a member of its original basic-level category. But contrary to this prediction from Principle 1, participants thought that the individual continued to exist but was no longer a member of its basic-level category in 81.7% of responses. For the
Table 1

A scenario and corresponding questions for a trial in the artifacts condition in Experiment 1.

The world’s oldest cup is kept on display at the Art Institute of Chicago in Chicago, Illinois. The staff members at the Art Institute refer to this cup as Sippy. One day, a staff member at the museum drops Sippy. Sadly, when this happens the world’s oldest cup shatters into many pieces.

1. The museum staff refer to the world’s oldest cup as
   (a) Sippy  
   (b) Steven  
   (c) Sam  
   (d) Slurpy

2. After the world’s oldest cup shatters, Sippy
   (a) is still a cup.  
   (b) is no longer a cup.

3. After the world’s oldest cup shatters, Sippy
   (a) exists as a pile of pieces.  
   (b) no longer exists.

Table 1 example, they usually decided that Sippy still exists as a pile of pieces but is no longer a cup. Consequently, these findings suggest that people do not follow Principle 1 when making judgments about the identity of artifacts or natural kinds.

These results appear in Fig. 1, which plots the percentage of responses (over both participants and scenarios) that fell into each of the four cells created from the questions Does the individual still exist? and Is the individual still a member of its basic-level category? (e.g., Questions 2 and 3 in Table 1). This cross-classification highlights the fact that by far the most frequent combination of responses was the individual continues to exist at the end of the transformation but outside its original basic- and superordinate level categories.

To analyze the data, we took as the dependent variable the category from Fig. 1 that a participant’s response fell into on a particular trial [i.e., whether the participant responded that the entity was: (a) in its original sortal and still existed after the transformation, (b) was in the original sortal but no longer existed, (c) was no longer in the original sortal but still existed, or (d) was no longer in the original sortal and did not exist]. The independent variable was whether the original object in the scenario was an artifact or a natural kind. We used a multinomial logit mixed model to analyze these data (e.g., Agresti, 1990), treating participants as a random effect. As Fig. 1 indicates, one of the cells in this design had no responses (sensibly, no one thought that an individual member of a natural kind does not exist but nevertheless remains in the same basic-level category). So to avoid difficulties in fitting the model, we added one response to each cell of the design. (We follow the same procedure in all experiments reported here.) The resulting analysis confirms the difference among the four response categories, \( F(3,112) = 75.15, p < .001 \). As we’ve noted, the response that the object still exists but is no longer a member of its original category dominates the other three response types (smallest \( t(91) = 6.99, p < .001 \)). There was no significant effect of whether the object in question was an artifact or a natural kind, \( F(3,494) = 1.34, p = .26 \).

One potential issue about these results concerns Question 3 from Table 1. Might participants have understood answer option (a)—“exists as a pile of pieces”—to mean Sippy still exists (as a member of the physical object sortal) when it has become a pile of pieces? Perhaps the many “yes” answers to Question 3 reflect this interpretation. But if participants were responding in this way, then they were not understanding “physical object” in the psychosortalists’ sense. That is, they were not understanding “physical object” to refer to a Spelke object (i.e., a bounded, coherent, three-dimensional entity that moves as a whole), since a pile of pieces is not a coherent entity and doesn’t move as a whole. Thus, even if participants chose (a) for this reason, the results still suggest that participants judge that an individual can persist across a change in its superordinate sortal category. We pursue this issue in Experiment 3, which asks explicitly about objects’ status as physical objects.

In short, the results from Experiment 1 suggest that psychortalism does not make the right predictions when it comes to people’s judgments about individual artifacts and natural kinds.

3. Experiment 2: Objection and replies to Experiment 1

Experiment 1 argues that people conceive of individuals as able to survive both their basic- and superordinate-level sortal categories. However, recall that psychortalists have objected that these transformation cases don’t tell us anything about how people actually identify objects over time. Rather they only show that participants are willing to pretend that objects can survive their sortals in fictitious contexts. We think that the transformations in Experiment 1 avoid this worry, since all the cases involve mundane examples of changes that objects undergo on a daily basis. Nevertheless, to address this objection more explicitly, Experiment 2 tests whether participants conceive of artifacts and non-human natural kinds as being able to survive transformations that alter their status even more radically than the transformations in Experiment 1.

Like Experiment 1, Experiment 2 asks whether participants conceive of six types of artifacts and six types of non-human natural kinds.
kinds as being able to survive a transformation across both their basic- and superordinate-level sortal categories. But in this study, the transformations were extreme. The trials in the artifacts condition involved items that were vaporized after being dropped from a high place. For instance, participants were asked to read a story about an individual cup, Sippy, that was vaporized after being dropped on the ground (see Table 2 for the exact wording). Similarly, the trials in natural-kinds condition involved individual pieces of fruit or vegetation that were turned into juice or small pieces and then vaporized. For example, participants read a story about an individual carrot that was vaporized after being turned into carrot juice. Participants were then asked to decide whether the item was still a member of its basic-level category and whether it still existed.

The idea here is that if psychosortalists are right in thinking that the participants in Experiment 1 were willing to say that individuals can survive their sortals only because they were reading a fictitious story, then psychosortalists should predict that participants would be willing to say that an individual is able to survive its sortal in any coherent fictitious context. For example, if participants in Experiment 1 were judging that Sippy can survive its sortal because they were playing along with the story, then participants should play along with the scenarios in Experiment 2 and judge that Sippy can survive after being vaporized. Do they?

### 3.1. Method

**Scenarios** like the one in Table 2 were presented to participants. Each scenario involved an artifact (a cup, a hammer, a ball, a desk, a chair, or a sewing machine) or a natural kind (a tree, a leaf, a pineapple, a bush, a carrot, or an apple) from Experiment 1 that was vaporized. The procedure was otherwise the same as that of Experiment 1. One response was thrown out because the participant incorrectly answered the screening question (similar to Question 1 of Table 2).

Twenty-five college students were paid for completing this experiment. None of these participants had taken part in Experiment 1.

### 3.2. Results and Discussion

The purpose of this study was to find out whether the results in Experiment 1 were really due to participants’ judgments about individuals, or whether they should be chalked up to participants just going along with what was being said in the scenarios. If, as some psychosortalists have suggested (e.g., Rhemtulla & Xu, 2007), participants in Experiment 1 were just playing along with what they were reading, then participants in Experiment 2 should also judge that individuals can persist across a change in their basic- and superordinate-level sortal categories.

However, for only a minority of responses (30.7%) did participants judge that the transformed individual survived a change in its basic- and superordinate-level sortal categories. These participants thought, for example, that Sippy still exists but is no longer a cup in the Table 2 story. Rather, the modal response (51.0%) was that the transformed individual did not survive radical transformation and was not a member of its original category (e.g., Sippy ceased to exist and was no longer a cup). Participants do not always play along with the pretense of the scenario in preserving an object’s existence. Thus, we think it would be a mistake to write off the results from Experiment 1 on the grounds that participants always believe that a character in a story persists across transformations.

Fig. 2 displays the detailed results in a form similar to Fig. 1. A multinominal logit mixed model, like that of Experiment 1, showed that the four response categories again differ significantly, $F(3,72) = 12.63, p < .001$. This time, however, it’s the response that the object no longer exists and is no longer in its original category that is more frequent than each of the other three response types. The difference between the two most frequent categories (different sortal/does not exist and different sortal/still exists) is marginally significant, $t(72) = 1.82, p = .072$. The differences between the most frequent category and the remaining two (same sortal/does not exist and same sortal/still exists) are fully significant, $t(72) = 4.17$ and $t(72) = 4.22$, respectively, $p < .001$ in both cases. As in Experiment 1, the response distributions in Fig. 2 do not differ significantly for artifacts versus natural kinds, $F(3,422) < 1$.

The lesson here is that while people are willing to say that an individual can persist across a change in its sortal category, they are not willing to say that objects can survive any transformation whatsoever. This being the case, we think there is good reason to believe that the transformations in Experiments 1 and 2 really do shed light on how people think about the identity of individuals.

### 4. Experiment 3: The assembly and disassembly of artifacts

Experiments 1 and 2 involved cases in which an individual was transformed across both its basic-level and superordinate-level
sortals and then remained in this transformed state. However, this is not the only type of transformation that individuals can undergo. For often times objects are taken apart only to be put back together. For example, to make moving easier, we often take apart furniture and then reassemble it once it is moved to a new location. The present experiment examines how participants conceive of six types of artifacts that are disassembled and re-assembled later. For example, participants read a story about an individual table, Timmy, that is fully assembled on Monday, disassembled on Tuesday, and then reassembled on Wednesday (see Table 3 for the text of this story). The crucial question is what participants say about the individual while it is disassembled on Tuesday. Here is why.

Given their commitment to Principle 1, psychosortalists should make the following prediction: If participants judge that an artifact is no longer a member of its basic or superordinate-level sortal category when it is disassembled, then those participants should also judge that individual no longer exists. In other words, psychosortalists should predict one of these two outcomes: (a) if people use the TABLE sortal, say, to make judgments about the identity of Timmy, and if they believe that Timmy is no longer a table when it is disassembled, then they should not judge that Timmy still exists (since this would be to conceive of Timmy as persisting across a change in the table sortal, violating Principle 1). Or (b) if people use the PHYSICAL OBJECT sortal to make identity judgments about Timmy, and if they believe that while Timmy is disassembled it is no longer a bounded entity, then they should not judge that Timmy still exists (since this would be to conceive of Timmy as being able to survive its PHYSICAL OBJECT sortal, which would also violate Principle 1). This experiment checks whether either (a) or (b) is true.

Experiment 3 uses scenarios similar to those of Experiments 1 and 2 but with several changes that explore additional aspects of the psychosortalist thesis (see Table 3). In addition to focusing on disassembly and reassembly, the scenarios explicitly ask participants to make a judgment about whether the relevant individual belongs to the physical object sortal when it is disassembled. For example, Question 2 in Table 3 asks whether a disassembled object is a bounded, coherent, three-dimensional entity that moves as a whole. This was done for two reasons.

First, although Experiments 1 and 2 did explore whether participants conceive of individuals as being able to survive a change in their sortals, participants were not asked directly whether the transformed individual was still a member of the physical object sortal category (i.e., participants were not asked directly if they thought the transformed individual was a physical object). There is good reason to think that the participants in Experiments 1 and 2 did not conceive of the transformed individuals as still belonging to the physical object sortal. Huntley-Fenner et al. (2002) and Carey (2001) argue convincingly that people do not think of things like carrot juice as being a physical object, rather a substance. But because cases like these have been under-explored in the literature, it is worth asking participants to make an explicit judgment about whether particular individuals belong to this superordinate-level sortal category (see Rips & Hespos, 2015, for a review of research on object/substance differences).

Second, psychosortalists seem to have something technical in mind when they use the term physical object. It is not clear to us that most participants will read physical object as “a bounded, coherent, three-dimensional entity that moves as a whole.” For example, most people probably consider mountains to be physical objects, but they would not qualify as physical objects in the technical sense, since they don’t move. For this reason, we think the best methodology is not to ask participants about whether the transformed individual is a physical object per se, but to ask them about whether it is a “bound, coherent, three-dimensional entity that moves as a whole.” The hope is that by explicitly describing what a physical object is in terms that psychosortalists intend, we can be more certain that our questions are really getting at the PHYSICAL OBJECT sortal.

4.1. Method

Six scenarios like the one in Table 3 were presented to participants. Each trial involved an artifact that was disassembled and put back together later. The artifacts were desks, chairs, computers, tables, cell phones, and digital calculators. Each scenario was presented on its own page along with three corresponding questions. The six pages were put into a booklet and presented to participants in a random order.

Sixteen students from Northwestern University participated in this experiment for course credit. None of these participants had been in the previous two studies. As was the case in Experiments 1 and 2, participants were asked a comprehension question for which the answer was clearly stated in the scenario (e.g., Question 1 in Table 3). Five responses (two from one participant and three from another) were discarded because this question was incorrectly answered.

4.2. Results and discussion

Given Principle 1, psychosortalists should predict that if participants judge that an individual is no longer a member of either its basic or superordinate-level sortal category, then those participants should also judge that the individual no longer exists. The crucial data for evaluating this prediction come from the part of our stories in which the target object is disassembled. At this point, the object is unlikely to be in either sortal category. On Tuesday in the Table 3 story, for example, the staff member has disassembled Timmy and left it in pieces, and this situation invites the idea that what’s present is neither a table nor a physical object. So, according to psychosortalists, Timmy should have ceased to exist. However, participants rarely made this judgment (13.2% of responses), as Fig. 3 (white bars) shows. This suggests that people do not satisfy Principle 1 when deciding about the identity of artifacts.

Instead, the most popular answer (47.3%) to the second question was that an individual artifact could survive a change in both its basic- and superordinate-level sortal categories (e.g., an individual that was once a table could still exist even if it was no longer a table or a bounded entity). Participants chose this response significantly more often than “does not exist” (a statistical test of this difference appears below). This further suggests that people pay little heed to basic- and superordinate-level sortal concepts when making judgments about individuals.

It is also worth noting that the second most popular response (36.3% of responses) was that an individual could remain a member of its basic-level sortal while no longer being in its superordinate-
level sortal (e.g., a disassembled table could remain a table even though it was no longer a physical object). This is perhaps unsurprising, since there are many objects like tables that are disassembled only to be reassembled, and people might find it strange to say in these situations that the object goes out of existence for a brief period only to come back into existence when it is put back together (see Dink & Rips, 2014, for similar cases). That is, it does not seem entirely unintuitive to speak of an individual table that exists as a (disassembled) table when packed up in a moving box. The worry here for psychosortalists, though, is that if they are right in saying that there is a hierarchy of nested sortals, then it is necessarily the case that for any basic-level sortal category, $B$, and for any sortal category, $S$, that is subordinate to $B$, an individual is a member of $B$ only if it is also a member of $S$ (e.g., it is necessarily the case that all tables are physical objects). Thus, psychosortalists should predict that if participants judge that an individual is no longer a member of its superordinate-level sortal category, they should also judge that the individual is no longer a member of its basic-level sortal category. So it is hard to see how psychosortalists can explain why some participants thought an entity continues to be a table while no longer being a physical object.

One potential difficulty in interpreting these results is the possibility that participants responded that the disassembled item is neither a table nor a physical object (i.e., option (2d) in Table 3) without realizing that this committed them to the existence of the individual in question. Perhaps participants did not notice that they could explicitly indicate that the object did not exist (i.e., option (2e)) since this was the last choice in the list of possible answers. They therefore picked option (2d) instead as a satisfying choice. However, it seems unlikely that participants view non-existent objects as being located in museums (recall that (2d) says that the object is located in the museum’s West wing). So if they believed the object no longer existed after it was disassembled, option (2d) would be an odd way to indicate this belief. No participant commented on this issue.

Fig. 3 (dark bars) also shows that participants responded quite differently to the question about the state of the object after its reassembly (e.g., question (3) in Table 3). Once the artifact had been reassembled, nearly all responses (90.1%) affirmed that it was once again an artifact (e.g., a table) and a coherent physical object (option (3a)). Thus, most participants believed that an individual item could go from being a table and a physical object to being a non-table and non-object (when it was disassembled) and then back to being a table and a physical object (when it was reassembled).
We used a multinomial logit mixed model to analyze these data, as in the preceding experiments. The independent variable in this analysis was whether the question was about the items’ state while it was disassembled (e.g., Question (2) in Table 3) or reassembled (e.g., Question (3) in Table 3). The dependent variable was participants’ choice of one of the five answer options. This difference produced a significant effect of question, \( F(4,274) = 19.22, p < .001 \), corresponding to the difference in the shape of the two response distributions in Fig. 3. We also applied a similar model to the responses for Question 2 alone. This model confirmed that participants chose answer option (2d) (e.g., is not a table, is in the West wing of the museum, and is not a bound, coherent, three-dimensional physical entity that moves as a whole) more often than answer (2e) (no longer exists), \( t(60) = 2.22, p = .030 \), as a planned comparison.

Although a disassembled artifact, such as a table, is no longer a Spelke object, its individual parts (e.g., its top and its legs) are, of course, bound, coherent, three-dimensional entities that individually move as wholes. But this fact is of no help to proponents of Principle 1. Recall that the aim of Experiment 3 is to explore whether people judge that a fully assembled object at a given time is identical to a completely disassembled object at a later time: If participants judge that the two items are identical, then this would suggest that people believe that an object can survive a change in its basic and superordinate level sortal categories, contrary to Principle 1. For example, an individual table can survive a change in membership from the table and from the physical object categories. Even if participants believe that the pieces of the table are individually Spelke objects, the table itself is not, and Principle 1 incorrectly predicts that participants should think the table no longer exist.

We therefore think the results from Experiment 3 add further support to the claim that sortal concepts do not furnish the identity conditions for individuals.

5. Experiment 4: Psychosortalism and object individuation

In addition to providing identity conditions, sortal concepts are also thought to provide individuation conditions. The basic idea is that by possessing a sortal concept, C, we thereby come to possess the criteria for individuating those objects to which C applies. For instance, psychosortalism says that the TABLE sortal specifies conditions on what counts as one table versus two tables and so on. As Xu (2007, p. 400) puts it,

To answer the question “how many?”, we need to specify how many of what. If we were interested in counting the number of items in a room, we would receive different answers by asking “how many TABLES?”, “how many CHAIRS?” or “how many LEGS”? … Sortal concepts enable us to enumerate [these objects].

The idea is that if you possess the TABLE sortal, then you will be able to count tables. It is in this sense, then, that psychosortalism purports to provide an answer to Question 2 (see Section 1 of this article).

To investigate these claims, this experiment examines how participants individuate common artifacts when multiple objects of the same type are fastened together. For instance, participants read a story in which a craftswoman, Patricia, fastens six small picture frames together in a three-by-two arrangement and then gives the arrangement to her friend Paul. Patricia then states that she gave Paul one picture frame whereas Paul states that he received six picture frames from Patricia. Participants are then asked to decide how many picture frames Patricia gave to Paul (see Table 4 for the exact wording of this problem).

Given Principle 2, psychosortalism predicts that so long as participants possess the PICTURE FRAME sortal, then those participants should agree on a definite number of picture frames that Patricia gave to Paul. Because psychosortalism says that the PICTURE FRAME sortal specifies the conditions for what counts as one picture frame versus two picture frames versus three picture frames, and so on, the view predicts that participants who possess this concept should agree about whether Paul has six frames, or one frame, or some other number of frames. They should not say that he has either one or six frames, though, since if the PICTURE FRAME sortal really does provide counting conditions for picture frames, participants should agree on a single, non-disjunctive answer. As in the case of Principle 1, our aim is not to argue that people never satisfy Principle 2 when making judgments about how to individuate objects. Rather, our aim is to show that Principle 2 is false by providing counterexamples—cases in which sortal concepts do not furnish individuation conditions.

5.1. Method

Participants read six scenarios like the one in Table 4. Each of the scenarios involved an agent who gave an arrangement of artifacts to her friend. Each story involved one of six different artifacts: dressers, desks, boxes, windows, tables, and picture frames. We chose these items informally with the idea that each of them could potentially be combined with others of the same type to form a composite of that type (e.g., several picture frames could be joined to form a composite picture frame). In each scenario, a group of either four or six of these items was fastened together to create a single composite. One agent claimed that she gave one artifact to her friend, while the other agent claimed that he received a plurality of artifacts (four or six) as a gift. Participants then chose whether the first agent was correct, the second agent was correct, both were correct, or neither was correct. Each scenario was presented on its own page along with a corresponding question. The six pages were put into a booklet and presented to participants in a random order.

Seventeen students from Northwestern University participated in this experiment for course credit. These participants had not been in the previous experiments.

<table>
<thead>
<tr>
<th>Table 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A scenario and corresponding question for Experiment 4.</td>
</tr>
</tbody>
</table>

Patricia builds picture frames as a hobby. On Sunday morning she purchases six single picture frames from her local craft store. Each frame is dirty and is made of aluminum. On Sunday afternoon Patricia cleans each picture frame and paints the aluminum red. On Sunday night she fastens all six picture frames together in one three-by-two arrangement. She then gives the three-by-two arrangement to her brother, Paul, as a gift.

Patricia then tells her friend George that she gave Paul one picture frame for his birthday. However, Paul tells George that Patricia gave him six picture frames for his birthday. How many picture frames do you think Patricia gave to Paul?

(a) Patricia was correct. She gave Paul one picture frame.

(b) Paul was correct. He received six picture frames from Patricia.

(c) Both were correct. There is more than one correct way to count picture frames.

(d) Neither of them was correct.
5.2. Results and discussion

Participants did not agree on a single number of artifacts that one agent gave to another. Fig. 4 shows that for 18.6% of responses participants judged that the agent who arranged the artifacts was right that she gave one object to her friend, while for 23.5% of responses they judged that the agent who received the arrangement was right that he received a plurality of objects as a gift. However, for the majority of responses (57.8%), participants judged instead that there was more than one correct way to count the number of objects that one agent gave to another. Consequently, these results suggest that people do not obey Principle 2 when making judgments about the identity of artifacts.

This is because Principle 2 predicts that if participants possess the PICTURE FRAME sortal, for instance, then those participants should agree on how to individuate picture frames. They should agree that one agent gave a determinate, non-disjunctive number of picture frames to her friend. However, most participants did not make this judgment.

A multinomial logit mixed model, similar to that of Experiment 3, confirmed that the distribution of responses in Fig. 4 was non-uniform, $F(3,63) = 12.34, p < .001$. Moreover, the response that both agents were right in their counts was reliably more frequent than either the response that one object existed ($t(22) = 3.17, p = .004$) or that multiple objects existed ($t(20) = 2.65, p = .015$). (The $t$-tests were based on the multinomial analysis, just reported.) Although there were not enough stimulus artifacts for a formal items analysis, we note that for all six items (picture frames, dressers, boxes, etc.) the modal response was that both characters were correct in their counts. The percentage of participants who chose this response ranged from 47% to 71% across items.

This being the case, we think that Experiment 4 suggests that Principle 2 is false and that, consequently, psychosortalism does not provide an adequate answer to Question 2, the question of how we individuate objects.

6. Experiment 5: Counting disassembled artifacts

Experiment 4 involved cases in which participants were asked to count artifacts that were fastened together. In addition to cases like these, situations in which artifacts have been disassembled and then put back together can also shed light on Principle 2 and on the extent to which sortal concepts furnish individuation conditions. For instance, how do participants individuate tables that are taken apart only to be reassembled later?

Experiment 5 examines how participants conceive of six types of artifacts—desks, chairs, computers, tables, cell phones, and digital calculators—that undergo such a process. In one condition, participants read scenarios about two agents who disassemble objects of one type of artifact (e.g., ten tables) and then reassemble all of them later. In a second condition, participants read similar scenarios, but the agents put only half the objects back together. Table 5 provides an example of one of the latter stories.

The crucial question here is how participants count the artifacts after only half of them have been reassembled. For given Principle 2, psychosortalism predicts that insofar as participants possess the TABLE sortal, say, then those participants should agree on how many tables are in a room even if some of those tables are disassembled. Certainly, none should say that “there is more than one way to count tables” (alternative (c) in Table 5).

6.1. Method

A between-subjects design was used here. Six scenarios like the one in Table 5 were presented to participants. Half the participants read scenarios in which each of a set of objects is taken apart and put back together, and the remaining participants read scenarios in which each of the same set of objects is taken apart but only half are put back together. Each of these scenarios involved museum staff shifting either eight or ten artifacts from the East wing of the museum to the West wing, as in Table 5. The procedure was otherwise the same as in the preceding experiments.

Thirty-two Northwestern students took part in this experiment. They were enrolled in introductory psychology and received course credit for their participation. None had been in the previous studies.

6.2. Results and discussion

Psychosortalists’ Principle 2 predicts that participants in both conditions should believe that there are a determinate number of artifacts at the end of the day. That is, given Principle 2, psychosortalism predicts that in both conditions participants should choose one of the answers (a), (b), or (d) from Table 5 and should shun answer (c)—that there is more than one way to count artifacts.

Fig. 5 shows that this prediction was correct when all target objects were reassembled. For 91.6% of responses in this condition, participants judged that there was same number of artifacts in the museum’s West wing at the end of the day as there had been in the museum’s East wing that morning. This widespread agreement is consistent with Principle 2.

However, when only half the objects were reassembled, the results run contrary to Principle 2. For although Principle 2 suggests that there will be significant agreement on the number of artifacts in the museum’s West wing at the end of the day, the results indicate that there was no significant agreement on any one answer. Fig. 5 shows that the responses were about equally split among options (a) all the original objects exist, (b) half the original objects exist, and (c) both of the preceding options are correct. A multinomial logit analysis, similar to that of the previous experiments, found a significant difference between the two conditions (all objects reassembled vs. only half the objects reassembled), $F(3,92) = 5.67, p = .001$. (As in the earlier analyses, we added 1 to each cell to avoid 0 frequencies.) Within the half-objects-reassembled condition, we found no significant differences in the frequency with which participants endorsed the options that half the objects exist versus all the objects exist ($t(18) = 0.51, p = .615$) nor between the options that both answers are correct versus all objects exist ($t(19) = 1.00, p = .331$).

The results from the condition in which only half the artifacts were reassembled shows that no particular answer is statistically dominant, and we take the lack of significance to count as a strike against Principle 2. Are we concluding too much from a null result? After all, perhaps the lack of significance is due to an error in exper-
Fred and Jane are staff members at the Art Institute of Chicago. Today their boss has assigned them the job of moving ten display tables from the East wing of the museum to an empty room in the West wing. In the morning Fred and Jane disassemble all ten tables and put the respective parts into ten moving boxes. In the afternoon they move all ten boxes into the empty room in the West wing. In the evening Fred and Jane reassemble five tables in exactly the same way they were put together before.

Before he leaves work for the day Fred tells his boss that there are ten tables in the West wing of the museum. However, Jane tells her boss that there are five tables in the West wing of the museum.

How many tables to you think are in the museum’s West wing?

(a) Fred was correct. There are ten tables in the West wing.
(b) Jane was correct. There are five tables in the West wing.
(c) Both are correct. There are five tables in the West wing.
(d) Neither is correct.

Fig. 5. Percentage of responses for the question about how many objects exist after being moved. The x-axis represents the question from Table 5. Because the bars represent response distributions, the sum of the light-colored bars is 100%, as is the sum of the dark-colored bars. The percentages are calculated over all participants and scenarios.

7. General discussion and concluding remarks

Psychosortalism contends that sortal categories furnish the identity and individuation conditions for their members. This theory is deeply interesting since, if it is true, it provides us with answers to Questions 1 and 2, revealing the basis of people’s ability to identify and discriminate objects. The five experiments presented here, however, suggest that appealing to sortal concepts cannot fully explain these skills.

Experiments 1 and 3 found that people conceive of artifacts and non-human natural kinds as being able to survive both their basic- and superordinate-level sortals, and Experiment 2 suggests that these transformation scenarios really are getting at peoples’ singular concepts (as opposed to just getting at how they respond to fictitious stories). People believe that what was once a particular chair, for example, can continue to exist as a pile of pieces while denying that it remains a chair or even a “physical object” (in psychosortalists’ favored sense of bounded 3D object that moves as a whole). Limits exist, however, on people’s willingness to believe that a singular entity continues to exist. Completely incinerating an object, for example, puts an end to it.

Experiments 4 and 5 found that sortal concepts do not provide individuation conditions for artifacts. The participants in Experiment 4 did not agree on a particular way of counting artifacts that have been fastened together, and those in Experiment 5 did not agree on how to count objects that have been disassembled only to be put back together. Instead, many participants thought that there was no single way to count these entities as members of common sortal categories, such as chair or table. For example, on being asked how many tables were present, participants were unable to use the sortal table to arrive at a determinate answer. As far as we know, no other experiments have directly addressed this issue.

Of course, limits exist on the scope of these findings. For example, it is possible that our results depend in some ways on the exact wording of our vignettes. Perhaps people are more likely to violate Principles 1 and 2 under some framings but not under others. But if there is a framing effect of this sort, then this would be a result that all parties would need to explain. Both psychosortalists and non-psychosortalists would need to develop new explanations as to how the different wordings are driving these results.

Along similar lines, Experiments 1–3 used proper names to identify and ask questions about the existence of individuals. Psychosortalists might argue that this is problematic, since having a proper name could suggest that the relevant individual is not merely an instance of a kind, but one with a privileged status, perhaps some non-material nature that can survive its material destruction. But although the role of proper names is worthy of further study in this context, we doubt that substituting other referring expressions for proper names would get psychosortalism out of trouble. Our reason for using proper names is that they provide one of the best, most intuitive, ways of determining whether participants believe that pre-transformation and post-transformation objects are identical. And this is because proper names are typically understood as rigid designators (Kripke, 1980), tracking the same individual across possible situations. Moreover, even if there was an effect due to the individual objects having proper names, it is not clear how psychosortalists would be able to explain the data. For Principle 1 makes no provision for whether an individual object is named or has some social significance. In all cases, people should judge that an object cannot survive a change in sortal categories, contrary to the results of Experiments 1 and 3. Psychosortalists could propose a weakened version of Principle 1 that makes exceptions for named individuals, but it is unclear what the basis for this revision would be.
Finally, we have argued that the results found here suggest that adults do not represent the identity and individuation conditions specified by Principle 1 and Principle 2. Consequently, we think there is at least good prima facie reason to think that infants do not represent these principles either. However, whether or not infants really do possess sortal concepts (i.e., whether or not infants but not adults represent Principle 1 and Principle 2) is ultimately an empirical question that needs to be examined in future work.

7.1. The continuity of objects over change in sortal category

These results extend the research of Blok et al. (2005) and Rips et al. (2006). Like previous transformation experiments, these results support the “antipsychosortalist” position that sortal concepts do not dictate the way people trace the identity of individuals. However, these experiments differ from previous studies in two important ways. First, unlike earlier work, these experiments presented participants with scenarios that corresponded to real world transformation cases—ordinary breaking and disassembly. This avoids the worry that the experiments are too far-fetched to uncover participants’ true judgments about the identity of various individuals. Second, the present results show that people employ neither basic-level nor superordinate-level sortal concepts when making judgments about individuals. This is unlike previous research, which investigated only whether people employ basic-level sortal concepts when making identity judgments.10

These results also compliment Hall’s (1998) findings that people believe that an individual artifact can survive being completely disassembled when that object is put back together. Hall (1998) found that if an artifact—a star-shaped object described as a kind of paperweight—is fully assembled at a time, t1, and then disassembled at a later time, t2, and then reassembled at an even later time, t3, people judge that the object at t1 is identical to the object at t3. The results from Question 3 of the present Experiment 3 echo Hall’s (1998) findings, and both studies cast doubt on the intuitive idea that if an object at an earlier time is identical to an object at a later time, then the two objects must be spatiotemporally continuous. What is especially interesting for our purposes, though, is the data from Question 2 of Experiment 3. This question asked whether a fully assembled individual at one time could be identical to a completely disassembled individual later. We found that a substantial number of participants agreed that this could be the case (see Fig. 3, light-colored bars). We think that this puts pressure on Principle 1, since these results suggest that people judge that an individual can continue to exist even if it is no longer a member of its basic or superordinate level sortal categories. For example, people judge the individual cup, Sippy, can persist even if it is no longer a member of the CUP or the PHYSICAL OBJECT categories.

The results found here also substantiate earlier observations in Keil (1989) and Bloom (2000). For instance, Keil (1989) found that people believe that individual artifacts can persist across a change in their basic level sortal categories. For example, people believe that an individual coffee pot can become a birdfeeder. Similarly, Bloom (2000) observed that people find it felicitous to say things like This school used to be a post office and This road used to be a bike path. Bloom’s point is that people seem comfortable in tracing the identity of an individual (e.g., a school) across a change in basic-level sortal categories (e.g., from the school category to the post-office category), which also seems to fly in the face of psychosortalism. These results also seem to put pressure on Principle 1, since they too suggest that people believe that individuals can persist across changes in their basic-level sortal categories.

Of course, psychosortalists can respond by saying that the reason people can make sense of the transformation cases in Keil (1989) and Bloom (2000) is that they conceive of the same physical object as underlying the pre- and post-transformed individual. For example, the individual coffee pot and the individual birdfeeder both belong to the physical object sortal. However, the results obtained here suggest that this line of response will not work in all transformation cases. Bloom, for instance, would have been right to note that most people also find it felicitous to say things like These pieces used to be a cup and This pile of woodchips used to be a tree. And psychosortalists cannot appeal to peoples’ PHYSICAL OBJECT sortal to make sense of these claims, since a bunch of cup pieces and a pile of woodchips are not physical objects. Experiments 2 and 3 provided data that support this claim.13

Perhaps psychosortalists could offer a different kind of response by arguing that sortal concepts, as people actually conceive them, furnish only fallible identity conditions.12 Instead of saying that sortal concepts specify that individual objects can never persist across a change in sortal categories, psychosortalists could weaken this claim and say that sortal concepts specify that individual objects usually do not, or probably do not, persist across a change in sortal categories. The results from Experiments 1–3 may not pose a problem for this revised view. After all, the results from these experiments only show that there are cases in which people judge that an individual can survive its basic and superordinate sortal categories, and clearly this is compatible with the claim that people usually judge that individuals cannot persist across changes of this sort. Another way of putting this issue would be to suggest that sortals provide metaphysical (or normative) principles for identity and individuation, whereas people can use only heuristic (or probabilistic) versions of these principles. If so, the results of these experiments would show that people were making errors in their judgments of identity and individuation, but would leave the normative status of sortals untouched.

But notice that this proposal leaves psychosortalism in danger of vacuousness. For everyone agrees that sortal information can be relevant for identity and individuation in some circumstances. If people see a dog now and an elephant later, they can use that fact as evidence that the two are probably not identical. But the same is true of nonsortal information as well. If we see a cubical object now and a spherical object later, we can use that fact as evidence that the two are also non-identical. Even infants can make use of nonsortal information like this when identifying and individuating objects (e.g., Futo, Teglas, Csibra, & Gergely, 2010; Wilcox, 1999). But psychosortalism is presumably making a stronger claim about the privileged nature of sortal information (e.g., relative to knowledge of ordinary properties), and it simply isn’t clear how the weakened version is able to do this. Notice, too, that the scenarios of Experiments 1–3 do not describe the transformations in a way that would cause participants special difficulties in applying the relevant sortal concepts. In Experiment 1, for example, participants agreed over 80% of the time that the transformed object was no longer in its original sortal category (see Fig. 1). So it is unclear

10 See Blok et al. (2005) and Rips et al. (2006) for a more positive proposal here, and see Rhemtulla and Xu (2007) for a critique.

11 Psychosortalists do recognize that not all sorts provide identity conditions for the full lifetime of an individual. For instance, caterpillar is considered a phase sortal since it applies to only a phase of the individual’s existence. Can an appeal to phase sorts save the psychosortalist here? That is, can the psychosortalist say that PHYSICAL OBJECT is a phase sortal and that there is thus nothing problematic about people judging that an object persists across a change in this superordinate sortal category? This seems unlikely. If for PHYSICAL OBJECT is a phase sortal, to what sortal category would the object belong after it was no longer judged to be a physical object? Given that there do not appear to be any plausible candidates, it does not seem like an appeal to phase sorts will be useful (see Wiggins, 2001, and Xu, 1997, for a discussion of phase sorts).

12 See Macnamara (1986, pp. 129–130) for this approach. See also Carey and Xu (1999) who hint at this line of thought.
why participants would pass up the opportunity to use sortal information in deciding about identity in these situations. Although certain cases might arise in which the facts about sortals are obscure and thus justify some nonsortal strategy, the present examples do not seem to be of that kind. Thus, should they opt for this line of response, psychosortalists would seem to have the burden of showing how this revised theory is psychologically interesting.\textsuperscript{13,14}

7.2. Sortals and countability

Experiments 4 and 5 both tell against Principle 2, since participants in both experiments failed to agree on a single, non-dissociative way of counting members of everyday sortal categories. While we know of no other experiments that explore the role that sortal concepts play in counting objects in this way, the results found here resonate with earlier research on concepts. For recall that before the 1970s many people held a classical view of concepts according to which concepts are mentally represented as definitions. For example, on this view, concepts like TABLE and CUP are said to provide the necessary and sufficient conditions for what it takes to be a member of the table and cup categories. Of course, well known problems for the classical view have led many cognitive psychologists to abandon the idea that concepts provide definitions for category membership (see Murphy, 2002, chap. 2, for a nice overview).

Psychosortalists appear to be stuck with a problem that parallels this difficulty for the classical view. The conditions for identity and individuation that sortal theories posit are supposed to be necessary and sufficient conditions (see Lowe, 1989a, for a clear formulation). For example, if the sortal concept TABLE allows people to count the number of tables in a room, that’s because the concept specifies the necessary and sufficient conditions for what makes one table different from the next. But if proponents of the classical theory had a hard time showing that people really do represent necessary and sufficient conditions for category membership, it is likely that psychosortalists will have an equally hard time showing that sortal concepts furnish necessary and sufficient conditions for individuation. We know of no attempt by psychosortalists to spell out the individuation conditions for even one everyday sortal concept, and Experiments 4 and 5 suggest that this will be a difficult task indeed. (See Blok et al., 2007, for a similar point about sortal concepts and identity conditions.)

Perhaps psychosortalists could defend their theory by saying that sortal concepts have flexible construals such that the same thing could be thought of as a single thing (e.g., a picture frame) or a collection of things (six picture frames). That is, perhaps it could be argued that because sortal concepts allow for different ways of conceiving of a situation, they furnish a variety of different but equally correct ways of counting how many instances of a kind are present. A problem with this objection, however, is similar to one we mentioned in connection with identity: It threatens the status that sortal concepts are supposed to have relative to nonsortal concepts. Consider a concept like RED THING, which is not taken to be a sortal concept (e.g., Carey & Xu, 1999; Lowe, 1989b, pp. 10–11; Thomasson, 2007, pp. 110–118). Why isn’t RED THING a sortal? As E.J. Lowe put it (1989b, p. 10; original emphasis):

\ldots there are ways of counting the number of men or tables or books in a given room, but no way of counting the number of red things. \ldots Suppose, for example, that the room contained a red table: then that, it might be urged, is clearly one red thing. But what about its red top and its red legs, or the red knob on one of its red drawers? Are these to be counted as different “red things” in the room in addition to the red table itself? And what about, say, the red paint covering one of the table’s legs: is that also to count as a distinct “red thing” in its own right? It rapidly becomes apparent that there is no principled way of deciding these matters, until we are told what sorts of red thing we are supposed to be counting.

Lowe’s point is that sortals like MAN furnish individuation conditions that provide us with a principled way of determining how many men are in a room. If you ask How many men are in the room? the MAN sortal furnishes the conditions that will allow you to come up with a single correct answer. However, a concept like RED THING does not furnish a principled, non-arbitrary way of deciding how many red things are in the room. Rather, there are many different ways of counting the red things. Thus, because one can arbitrarily decide how many red things there are, RED THING does not furnish the necessary principles of individuation and cannot, therefore, be a sortal concept. (See Carey & Xu, 1999, for a similar argument about why terms like red thing cannot be sortals.)

But given the results from Experiments 4 and 5, the argument against RED THING being a sortal seems to apply to concepts like PICTURE FRAME and TABLE as well. For instance, the results from Experiment 4 suggest that people do not agree that there is a single, non-arbitrary way of counting picture frames. Rather, the results suggest that people agree that there is more than one correct way of counting these objects. Thus, if the reason that RED THING is not a sortal term is that there is more than one way in which one could count the red things, then PICTURE FRAME is not a sortal term that furnishes individuation conditions either. The appeal to flexible construals is too weak in the sense that it does not allow one to rule out terms like red thing as being sortals. Perhaps the psychosortalist could try to accommodate this worry by arguing as follows: PICTURE FRAME and RED THING both have flexible construals, but what makes the former a sortal concept is that every instance of a picture frame belongs to one category (i.e., the picture frame category), whereas the instances of the latter can belong to different categories (e.g., the picture frame category, the piece of red wood category, the red screw category, etc.). That is, what distinguishes sortal terms from non-sortal terms is that the former only refer to objects in one category, whereas the latter can refer to objects that belong to many different categories. There are two issues with this reply. First, the argument fails to point to a difference that actually distinguishes RED THING from PICTURE FRAME. Notice that while it is true that all picture frames belong to the picture frame category, it is also true that all red things belong to the red thing category. It is just trivially true that all picture frames are picture frames and that all red things are red things. Moreover, just as the instances of the red thing category can belong to other categories as well (e.g., red frame, red piece of wood, red screw, etc.), instances of the picture frame category can belong to other categories too (e.g., wooden boxes, rectangularly-shaped metal tubing, etc.), can all serve as picture

\textsuperscript{13} Notice that an analogous point can be made about Principle 2 and Experiments 4 and 5. That is, proponents of Weak Psychosortalism endorse Principle 2*-weak: If H possesses a sortal concept, S, of some category, C, then H will usually be able to individuate members of C in virtue of possessing S. However, the same arguments given against a weakened version of Principle 1 will apply here as well. Thus, we are skeptical that Weak Psychosortalism in general is going to succeed. See also Goodman (2012) for a discussion of why, in order to maintain an interesting and distinctive position, sortalists really are committed to principles like Principle 1 and Principle 2 (or some similar formulation).

\textsuperscript{14} Of course, exploring the normative implications of these results is an important task. However, in order to know if participants were making reasoning errors, we would first need to determine the essential properties of the natural kinds and artifacts that were used in our studies. For instance, in order to know if people are mistaken that an individual cup can survive a change in its basic and superordinate level sortal categories, we would first need to develop and defend a view about the essential properties of artifacts like cups. This question is very much up for grabs in the literature on the metaphysics of artifacts. But exploring this issue would take us far beyond our present focus on cognitive theory.
frames). Thus, this response does not point to a feature that distinguishes RED THING from PICTURE FRAME.

To see the second problem with this response, consider the PHYSICAL OBJECT sortal that some psychosortalists (e.g., Carey & Xu, 1999; Xu, 1997) maintain is important for making sense of much of the infant data, as well as the some of the transformation data cited in Section 1.2. According to these psychosortalists, “physical object” is a sortal term that refers to any bounded, coherent, three-dimensional entity that moves as a whole. Thus, if RED THING is not a sortal concept because there are many different types of things that belong to the “red thing” category (e.g., red picture frame, red piece of wood, red screw, etc.), then by the same line of reasoning it would follow that PHYSICAL OBJECT is not a sortal either, since clearly there are many different types of things that belong to the “physical object” category too (e.g., red picture frame, red piece of wood, red screw, etc.). Thus, if the psychosortalist endorses this response, she will have the problem of denying that there is a PHYSICAL OBJECT sortal, which by her own lights would be problematic.15

The issues here can be summarized in the form of a dilemma for psychosortalists. On the one hand, suppose that sortal concepts are said to furnish individuation conditions in the strong sense specified by Principle 2 (i.e., Principle 2 with no mention of flexible constraints, or any other modifications). Then while psychosortalists would have a potential way of distinguishing sortal concepts like PICTURE FRAME from non-sortal terms like RED THING (i.e., the former furnishes individuation conditions whereas the latter does not), the results from Experiments 4 and 5 strongly suggest this version of psychosortalism is false. On the other hand, suppose that sortal concepts are said to furnish individuation conditions in a weaker sense (e.g., in the sense specified by Principle 2 along with the notion of a flexible construal). Then while psychosortalists would have a potential way to accommodate the results from Experiments 4 and 5, they would run into the problem of showing how their theory was not so weak that it would also include RED THING as being a sortal concept too.

The challenge for the psychosortalist, then, is to articulate a view according to which (a) sortal concepts have flexible construals, (b) there is some feature that is strong enough to distinguish sortal concepts from non-sortal concepts like RED THING, and (c) this feature is not so strong that it in addition to RED THING, it also rules out PHYSICAL OBJECT from counting as a sortal concept as well.

7.3. Concluding comment

Of course, we should not forget what seemed appealing about psychosortalism in the first place. We think that psychosortalists are right when they say that in order to count the number of things in a room you must possess the concept that applies to the things you are counting. It would be wrongheaded to think that people could reliably count the number of tables in a room if they did not have the concept TABLE. And we also agree that in order to know whether an individual is the same table as it was ten years ago you would have to have the TABLE concept to make this judgment. Our only point here is that the TABLE concept itself does not provide the necessary and sufficient conditions for identifying and individuating tables. And the same goes for all other sortal concepts.

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References


15 See also Goodman (2012, p. 95) for more discussion of the PHYSICAL OBJECT sortal.