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## Well-Hidden Regularities: Abstract Uses of *in* and *on* Retain an Aspect of Their Spatial Meaning

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### Abstract

Prepositions name spatial relationships (e.g., book *on* a table). But they are also used to convey abstract, non-spatial relationships (e.g., Adrian is *on* a roll)—raising the question of how the abstract uses relate to the concrete spatial uses. Despite considerable success in delineating these relationships, no general account exists for the two most frequently extended prepositions: *in* and *on*. We test the proposal that what is preserved in abstract uses of these prepositions is the relative degree of *control* between the located object (the figure) and the reference object (the ground). Across four experiments, we find a continuum of greater figure control for *on* (e.g., Jordan is *on* a roll) and greater ground control for *in* (e.g., Casey is *in* a depression). These findings bear on accounts of semantic structure and language change, as well as on second language instruction.

*Keywords:* Prepositions; Spatial language; Abstract language; Metaphor; Language understanding; Semantics

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### 1. Introduction

Prepositions are fascinating but elusive. They are highly frequent—along with determiners and pronouns, they constitute the most frequent form class. Prepositions have an important function: They name relationships between entities. Although we think of prepositions as naming spatial relationships (e.g., The cup is *on* the table), they also name abstract relationships, such as the relationship between a person and a state of mind (Mary is *in* a frenzy). These abstract uses are common, making up roughly 40% of preposition occurrences (Steen et al., 2010). Understanding how these abstract uses arise, and how they relate to the concrete spatial senses of the terms, is important for theories of semantic structure and language change. Abstract uses of prepositions are

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metaphorical because they go beyond the words' basic or standard meanings. Understanding these highly frequent and habitual metaphorical uses can help inform theories of metaphor. A further reason for interest in abstract uses of prepositions is that they play an important role in structuring discourse (e.g., Gruber, 1965; Jackendoff, 1976, 1983). For example, contrast "The conclusions drawn *in* his paper are spurious" with "The conclusions drawn *from* his paper are spurious." An account of how these abstract, non-spatial uses relate to each other and to spatial senses of the terms is crucial for computational theories of natural language processing, as well as for applications such as machine translation and second language learning. For all these reasons, understanding the abstract meanings of prepositions has been an important endeavor in both linguistics and psycholinguistics.

There have been some key advances in the understanding of abstract, metaphorical extensions of prepositions, and how they relate to the words' spatial uses: for example, uses of vertical terms to describe social hierarchies (e.g., The assistant works *under* the CEO) and other dimensional relations (e.g., Boers, 1996; Brugman, 1988; Lakoff & Johnson, 1980; O'Keefe, 1996); uses of prepositions to convey causal relations (e.g., He has insomnia *from* stress) (e.g., Bowerman, 1983; Clark & Carpenter, 1989; Dirven, 1993; Radden, 1985); and uses of prepositions in ontological metaphors in which events or actions are conceived as containers (e.g., He's *out of* the race now) (e.g., Lakoff & Johnson, 1980). In particular, temporal uses of prepositions have received a great deal of attention, and there have now been many insightful analyses of systematic mappings from space to time (e.g., Bennett, 1975; Boroditsky, 2000; Boroditsky & Ramscar, 2002; Casasanto, 2008; Clark, 1973; Gentner, Imai, & Boroditsky, 2002; Haspelmath, 1997; Jackendoff, 1976, 1983; Kranjec, Cardillo, Schmidt, & Chatterjee, 2010; McGlone & Harding, 1998; Quirk, Greenbaum, Leech, & Svartvik, 1985).

However, a significant gap in this body of knowledge is that there is no consensus account for the abstract uses of *in* and *on*—the most frequently extended prepositions in English (Cameron, 2003). In this paper, we propose and test an account of abstract uses of *in* and *on* that is based on the principle of *control*. Following Talmy (1983), we use the terms *figure* and *ground* to describe the participants in the relationship named by a preposition (e.g., a figure is *in* a ground, a figure is *over* a ground, a figure is *between* ground<sub>1</sub> and ground<sub>2</sub>). The basic idea is that *in* and *on* differ in the relative control of the figure–ground relationship. When used to name spatial relationships, *on* tends to convey relatively greater figure control of the relationship (e.g., a fly *on* the plate), and *in* tends to convey relatively greater ground control of the relationship (e.g., a fly *in* a hand). Our proposal is that this distinction is also extended to abstract uses of *in* and *on*. Elements of this proposal have appeared in earlier accounts of abstract *in* and *on* use, beginning with Garrod and Sanford's (1989) proposal (see also Beitel, Gibbs, & Sanders, 2001; Evans, 2010; Navarro i Ferrando, 1999, 2000). However, we believe that this work is the first to test the prediction that abstract uses of *in* and *on* are distinguished by the degree of figure and ground control.

We begin by reviewing accounts of spatial uses of *in* and *on*. Then we review accounts of abstract uses and describe our own *continuum of control* account in greater detail. We

then present four studies testing the predictions of the continuum of control account and discuss implications of the findings.

### 1.1. *Spatial uses of in and on*

Early accounts of spatial uses of *in* and *on* (e.g., Bennett, 1975; Cooper, 1968; Herskovits, 1986; Leech, 1969; Miller & Johnson-Laird, 1976) focused on the geometry of spatial relationships. Broadly, these accounts proposed that *in* names relationships that involve inclusion of the figure by the ground, and that *on* names relationships that involve contact between the figure and ground. However, more recent accounts (e.g., Bowerman & Pederson, 1992; Coventry & Garrod, 2004; Garrod, Ferrier, & Campbell, 1999; Garrod & Sanford, 1989; Talmy, 1983; Vandeloise, 1991, 1994) have stressed that in addition to geometric relations (such as inclusion), functional relations (such as containment), are important to preposition use. Functional relations concern the current or possible interaction between a figure and ground. The idea is that prepositions are “as much about *how* objects interact with each other as ... about the abstract positions of objects in Euclidian space” (Coventry & Garrod, 2004, p. 52). For example, saying that a pear is *in* a bowl conveys not only the geometry of the relationship between them but also the nature of this relationship: The bowl contains the pear. Functional relations, such as containment, allow us to make inferences about the figure–ground relationship that would not be possible based on geometric relations alone. For example, if a ground contains a figure, we can infer that if the ground were moved, the figure would move with it.

Garrod and Sanford (1989) proposed the functional relations of containment and support for *in* and *on*, respectively. Based on their idea that both relations involve some degree of *control* of the figure by the ground, they named them *control relations*. The notion of control was initially put forward in accounts of causative expressions (e.g., *cause*, *make*) (e.g., Brennenstuhl & Wachowicz, 1976; Givón, 1975; Smith, 1970; Talmy, 1988; Wierzbicka, 1988). An agent’s degree of control can be defined as the likelihood that the agent can successfully carry out his/her intentions (e.g., to bring about an event) (Brennenstuhl & Wachowicz, 1976). The likelihood of a positive outcome for an agent (i.e., success) is related to the agent’s degree of control. If an agent has a great deal of control, then the agent is likely to succeed in carrying out his/her intentions, and if an agent does not have control, the agent is likely to fail.

In relationships between two agents, a controller and a controlee, the degree of control of one agent is the inverse of the other. If the controller has full control, then the controlee will always behave in the way the controller intended. Alternatively, if the controller has little or no control, then the controlee can choose how to act and follow his/her own intentions (Brennenstuhl & Wachowicz, 1976). This definition of control is similar to the common definition: “the ability or power to decide or strongly influence the particular way in which something will happen or someone will behave” (Control [Def. 1], [n.d.]). Both suggest that an agent who has control can successfully carry out his/her intentions with regard to a set of events or the actions of another agent.

A number of accounts have highlighted the importance of control relations for spatial uses of *in* and *on*<sup>1</sup> (e.g., Coventry, Carmichael, & Garrod, 1994; Coventry & Garrod, 2004; Feist & Gentner, 1998, 2003; Garrod et al., 1999; Vandeloise, 1991, 1994), but the accounts have differed slightly in the way that they characterize these relations. For example, Garrod and Sanford (1989), Coventry (e.g., Coventry & Garrod, 2004; Coventry et al., 1994), and Vandeloise (1991, 1994)<sup>2</sup> proposed that both *in* and *on* involve the ground controlling the figure, and that *in* involves greater ground control than does *on*. According to these accounts, figures *in* ground and figures *on* ground will both be controlled by the ground, but the degree of ground control will be greater for figures *in* ground than for figures *on* ground. Feist and Gentner (2003) likewise proposed that *in* involves the ground controlling the figure. However, Feist and Gentner (2003) further suggested that *on* involves a degree of figure control. In other words, a figure *in* a ground is likely to move in a direction dictated by the ground, but a figure *on* a ground can follow its own path. Empirical research provides support for the importance of relative figure and ground control for *in* and *on* use. There is evidence that both *in* and *on* involve a degree of ground control (e.g., Coventry et al., 1994; Garrod et al., 1999), but also that *on* involves some degree of figure control (e.g., Feist & Gentner, 1998, 2003).

We propose that these findings can be integrated if control is conceptualized as a continuum that ranges from full ground control of the figure–ground relationship to full figure control of the relationship. Under this view, *in* is closer to the ground control end of the continuum and *on* is closer to the figure control end. Therefore, figures *in* ground should involve greater ground than figure control, and figures *on* ground should involve greater figure than ground control. When comparing figures *in* ground and *on* ground, figures *on* ground should have more control over their own actions than figures *in* a ground.

Our goal in this work is to test whether this *continuum of control* also holds for abstract uses of *in* and *on*. We first review evidence that this continuum applies within the spatial domain.

### 1.2. Empirical evidence for the importance of control in spatial uses of *in* and *on*

Control within the figure–ground relationship is often related to the geometric relationship between the figure and ground. For example, a highly concave ground is better able to contain, and therefore control the figure, than one that is only slightly concave. Preposition choices follow this pattern: People prefer to label a relationship between a figure and a concave ground “*in*” and to label a relationship between a figure and a flat ground “*on*” (e.g., Feist, 2000; Feist & Gentner, 1998). The tilt of the ground also matters. If a ground is tilted away from its normal orientation, it is less able to control a figure, and this diminishes the perceived appropriateness of figure *in* ground (Coventry et al., 1994).

Beyond the geometric relationship, there are three further ways in which control within the figure–ground relationship has been manipulated: by demonstrating independent movement of the figure or ground or their co-movement; by demonstrating that there could be an alternate source of control other than the ground; and by varying the animacy of the figure and the ground. Each has been shown to influence the acceptability of *in* and/or *on*.

If the ground moves and the figure moves with it, this suggests that the ground has control over the figure–ground relationship; this should be conducive to the use of *in*. Indeed, demonstrating co-movement of the figure and ground increases the use of *in* and demonstrating independent movement decreases its use (e.g., Coventry, 1992; Coventry et al., 1994). Similar effects have also been demonstrated in children as young as 4 years old (Richards, Coventry, & Clibbens, 2004), suggesting that speakers are sensitive to some aspects of figure and ground control from a young age.

The second way that control has been manipulated is by introducing an alternate source of control into the figure–ground relationship. Normally only the figure or the ground can control this relationship. However, if a figure’s location can be controlled either by the ground or by an alternate third entity, then people should perceive the ground’s control to be lower than it would be without the alternate source of control. Garrod et al. (1999) found that introducing an alternate source of control lowered acceptability ratings for both *in* and *on*. They also found that independent judgments of ground control and of preposition acceptability were strongly correlated (.83 for *in* and .98 for *on*), supporting the idea that the degree of control by the ground, as opposed to an outside entity, is important for both *in* and *on* use.

The final way in which control has been manipulated is by varying the animacy of the figure or the ground (Feist & Gentner, 1998, 2003). If a ground is animate, it should have more control over its relationship with the figure (e.g., by being able to control the figure’s location) than if it were inanimate. Likewise, if a figure is animate, then it should have more control over its relationship with the ground (e.g., by being able to leave the relationship). Feist and Gentner found that participants were more likely to label scenes “*in*” when the ground was animate (a coin *in/on* a hand) as opposed to inanimate (a coin *in/on* a dish) (Feist & Gentner, 2003), and more likely to label scenes “*on*” when the figure was animate (a firefly *in/on* a dish) as opposed to inanimate (a coin *in/on* a dish) (Feist & Gentner, 1998, 2003), suggesting that high ground control favors uses of *in* and high figure control favors uses of *on*.

Together, these findings demonstrate that relative control of the figure–ground relationship is important for spatial uses of *in* and *on*. More specifically, they suggest that while some degree of ground control may be important for both prepositions, uses of *in* tend to involve relatively greater ground control, and uses of *on* relatively greater figure control. Given these findings, we propose that the dimension of continuum of control is carried forward to abstract uses of *in* and *on*. For example, if *on* tends to convey greater figure control than *in*, then someone who is *on* the job market should be seen as having more control over the situation than someone who is *in* the job market. Before turning to details of our proposal, we review previous accounts of abstract *in* and *on* use and highlight aspects of these accounts that relate to control.

### 1.3. Previous accounts of abstract *in* and *on* use

Our hypothesis is that abstract uses of *in* and *on* preserve the continuum of control dimension from the concrete spatial uses. More specifically, we propose that abstract uses

of *in* involve relatively greater ground control and abstract uses of *on* involve relatively greater figure control. In other words, a figure *in* a ground is likely to act in a way dictated by the ground, but a figure *on* a ground can follow its own intended actions. This hypothesis is closely related to an early proposal by Garrod and Sanford (1989). They proposed that the functional control relations of containment and support might also be extended to non-spatial uses of *in* and *on*, respectively. As outlined earlier, they proposed that spatial uses of both *in* and *on* involve the ground controlling the figure, and suggested that abstract uses such as “*in* a bad mood” and “*on* social security” follow the same pattern. They also proposed that abstract uses of *in* involve greater ground control than abstract uses of *on*, which they illustrated by comparing the uses “*in* an alcoholic state” and “*on* the bottle.” The phrase “*in* an alcoholic state” suggests very high ground control, but the phrase “*on* the bottle” suggests a slightly lower degree of ground control. While Garrod and Sanford’s suggestion has not (to our knowledge) been empirically tested, it is compatible with the continuum of control account we propose and test here. Both accounts posit that *in* involves greater ground control than does *on*. However, whereas we further propose that *on* typically involves relatively greater figure than ground control, Garrod and Sanford proposed that both *in* and *on* involve greater ground than figure control.

Other accounts of the relationship between spatial and abstract uses of *in* and *on* (e.g., Beitel et al., 2001; Evans, 2010; Navarro i Ferrando, 1999, 2000) have been quite varied, differing in the number and kind of basic spatial meanings proposed, in the kind of correspondence assumed between spatial meanings and abstract uses, and in the degree to which spatial and abstract uses are assumed to draw upon the same aspects of the meaning. In general, these accounts propose many specific ways in which abstract uses of *in* and *on* relate to the prepositions’ spatial uses, some of which allow for difference in degree of control. Beitel et al. (2001) proposed that abstract uses of *on*<sup>3</sup> draw on one or more embodied spatial schemas (*support, pressure, constraint, covering, visibility*). Of the five spatial schemas they proposed, the one most similar to control is *constraint* of the figure by the ground. On this account, those abstract uses of *on* that draw on this schema involve the ground controlling the figure to some degree. Thus, relative degree of control is allowed for, though not emphasized, in this account. Navarro i Ferrando proposed two basic spatial schemas—enclosure for *in* (Navarro i Ferrando, 2000) and support for *on* (Navarro i Ferrando, 1999), each of which includes information about the topology, force-dynamics, and function of the figure–ground relationship. On this account, abstract uses of *in* and *on* can derive either from the basic spatial schemas (support or enclosure) or from one of the more specific schemas (topology, force-dynamics, function). The schemas can each lead to a number of abstract uses, with as many as 27 groupings of abstract uses deriving from a particular schema. Some of these implicate relative degree of control, but many do not. Finally, Evans (2010) proposed that uses of *in* and *on* involve enclosure and contact relationships, respectively, and that spatial and abstract uses draw on parameters derived from these basic relationships. Spatial uses of *in* draw on parameters that correspond to either the geometric properties of enclosure relationships (the parameter *enclosure*) or to the functional consequences of enclosure relationships (the

parameters *occlusion*, *location with surety*, *affecting conditions*). Abstract uses of *in* (e.g., *in pain*, *in banking*) derive from the *affecting conditions* parameter, which involves a figure being affected by the conditions of the ground (e.g., when John is *in pain*, John is affected by internal conditions resulting from being a state of pain). This account proposes that spatial uses of *on* draw on two parameters: the geometric parameter *contact* and the functional parameter *support*. In contrast, abstract uses of *on* (e.g., *on fire*, *on sale*) draw instead on a functional parameter termed *functional actioning*, which involves a figure becoming active as a consequence of contact with the ground. Though this account does not make any specific predictions about relative control, some of the parameters could be seen as influencing perceived control: For example, the *affecting conditions* parameter could be interpreted as involving greater ground than figure control because the figure may be affected by conditions of the ground involuntarily.

As Sandra and Rice (1995) have suggested, it is important to test whether linguistic accounts of preposition meaning accurately reflect distinctions made by language users. Unfortunately, the existing evidence is rather sparse, especially for non-temporal abstract uses. It has been shown that people do make a broad distinction between spatial and non-spatial uses of prepositions (including those of *in* and *on*), suggesting that these uses are distinct (Sandra & Rice, 1995). There is also neurological evidence that temporal and spatial uses of prepositions can be individually impaired (Kemmerer, 2005), suggesting these uses may draw on different aspects of preposition meaning. Finally, there is evidence that temporal uses of prepositions (including those of *in* and *on*) can influence how people think about time (Kranjec et al., 2010), suggesting that abstract temporal uses retain some aspect of their spatial meaning.

Our goal here is to test whether continuum of control is a key dimension preserved in abstract uses of *in* and *on*. We ask whether relative control carries into people's comprehension and production of these uses.

#### 1.4. *The continuum of control account of abstract uses of in and on*

According to the continuum of control account, the dimension of relative control of the figure-ground relationship is preserved in abstract uses of *in* and *on*. Further, more specifically, we hypothesize that abstract uses of *in* involve greater ground control of the figure-ground relationship, and that abstract uses of *on* involve greater figure control of the relationship. This predicts that we should find that figures *on* ground are perceived as having more control than figures *in* ground. Likewise, when judging ground control, grounds should be perceived as having more control for *figure in ground* than for *figure on ground* uses.

We now turn to our tests of the continuum of control account. In the first two experiments, we test whether conventional abstract uses of *in* and *on* are distinguished by the degree of figure and ground control. By collecting independent ratings of figure and ground control, we can assess our claim that figures *on* ground phrases lead people to infer higher figure control, and figure *in* ground phrases to infer higher ground control. In later studies, we test whether this aspect of meaning is generalizable—that is, whether it

is extended to novel abstract uses of these prepositions. Across studies, our tasks test both people's ability to infer a preposition's meaning, given its use (comprehension) and their ability to infer which preposition should be used, given information about a figure-ground relationship (production). If relative control is a salient aspect of *in* and *on* meaning, then we should find its effect both when comprehending and producing prepositions, and for novel as well as conventional abstract uses.

## 2. Experiment 1a

In Experiment 1a, we gave participants figures paired with conventional abstract *in* ground and *on* ground phrases, and asked them to rate the degree of figure control. We predicted that figures *on* ground would be rated as having greater control than figures *in* ground.

### 2.1. Method

#### 2.1.1. Participants

Thirty-two participants (21 female,  $M_{\text{age}} = 20.22$ ) were recruited from the Northwestern University community and received payment for their participation. All were native speakers of English.

#### 2.1.2. Materials

Participants saw 160 sentences, each made up of a human figure paired with a conventional abstract use of a preposition or verb (e.g., Casey is *in* a hurry). Forty-five of the sentences included a figure *in* a ground (e.g., Ali is *in* a rut) and 45 included a figure *on* a ground (e.g., Jessie is *on* a roll). Seventy filler sentences were made up of a figure paired with a conventional abstract use of another preposition or verb (e.g., Craig is *making* amends). The conventional abstract uses of *in* and *on* and of other prepositions and verbs were selected from online and print idiom dictionaries (e.g., Dictionary.com., 1995; Dixon, 1994; King & Flynn, 2002). We considered uses of prepositions to be abstract if their meanings went beyond the spatial meaning of the terms. A further criterion was *frequency*: We selected conventional *in* uses and *on* uses that were matched for frequency. The final criterion was *naturalness*, determined from ratings as described below. Animate, human figures were used for all of the sentences since figure animacy can affect preposition choice (Feist & Gentner, 1998, 2003). Each of the *in*, *on*, and filler phrases were randomly paired with common names. Those names that were paired with the *in* and *on* phrases were gender ambiguous.<sup>4</sup> Each of the sentences was followed by a figure control scale that ranged from 1 (*extremely low control of the situation by the person*) to 5 (*extremely high control of the situation by the person*).

In order to equate the naturalness of the *in* and *on* phrases, we collected naturalness ratings in a separate test. Twenty participants (13 female, average age = 33.25) were



recruited through Amazon Mechanical Turk and paid for their participation in the task. Participants rated the naturalness of 170 sentences made up of a human figure paired with a conventional abstract use of a preposition or verb. There were 50 figure *in* ground sentences, 50 figure *on* ground sentences, and 70 filler sentences. Participants rated each sentence's naturalness on a scale from 1 (*not at all natural*) to 5 (*extremely natural*). Using these ratings, we selected 45 *in* phrases and 45 *on* phrases that did not differ in their naturalness ( $M_{in} = 4.00$ ,  $SD = 0.50$ ,  $M_{on} = 4.10$ ,  $SD = 0.53$ ,  $t(88) = 0.70$ ,  $p = .483$ ,  $d = 0.21$ ), nor in their frequency (collected from the Corpus of Contemporary American English—COCA; Davies, 2008), raw frequency  $M_{in} = 559.24$ ,  $SD = 642.64$  (log frequency  $M_{in} = 2.51$ ,  $SD = 0.45$ ), raw frequency  $M_{on} = 584.66$ ,  $SD = 534.38$  (log frequency  $M_{on} = 2.58$ ,  $SD = 0.43$ ),  $t(88) = 0.77$ ,  $p = .445$ ,  $d = 0.16^5$ . These 90 *in* and *on* phrases were used in the experiment.

### 2.1.3. Procedure

Participants completed the task on the computer. They were instructed to try to imagine the scenario each sentence described and to “think about how much the person controls or is controlled by the situation.”

The sentences were presented one at a time on the screen along with the figure control scale. Sentences were presented in a pseudo-randomized order so that there were never two *in* sentences or two *on* sentences in a row and so that there were never more than two test sentences (*in* and *on* sentences) in a row. Participants read each of the sentences and completed the corresponding figure control scales.

## 2.2. Results

As predicted, relative control distinguished conventional abstract uses of *in* and *on*. Participants rated figures *on* ground as having more control ( $M = 3.30$ ,  $SD = 0.26$ ) than figures *in* ground ( $M = 2.88$ ,  $SD = 0.18$ ),  $t(31) = 8.60$ ,  $p < .001$ ,  $d = 1.88$ . Item analyses revealed a similar pattern of results. Figures *on* ground were rated as having more control ( $M = 3.30$ ,  $SD = 0.74$ ) than figures *in* ground ( $M = 2.88$ ,  $SD = 0.83$ ),  $t(88) = 2.56$ ,  $p = .012$ ,  $d = 0.55$ . Figure control ratings for all of the *in* ground and *on* ground phrases are listed in Appendix A.

### 2.3. Discussion

As predicted, in Experiment 1a we found that conventional abstract uses of *on* convey greater figure control than conventional abstract uses of *in*, supporting the continuum of control account. This pattern of results is also consistent with Garrod and Sanford's (1989) proposal that abstract uses of *in* involve relatively greater ground than figure control, as well as with their claim that the figure has more control with *on* than with *in*. However, these results are not consistent with their suggestion that, like *in*, uses of *on* also involve relatively greater ground than figure control. If this were the case, then figures *on* ground should be rated as having low control. We did not find this pattern of

results: figures *on* ground were rated as having high control (i.e., higher than 3 on the 1–5 figure control scale) ( $M = 3.30$ ,  $SD = 0.26$ ),  $t(31) = 6.69$ ,  $p < .001$ .

Many uses of *on*, such as “*on* top of it,” “*on* the money,” and “*on* a roll,” suggest not only high figure control but also a positive outcome for the figure. Likewise, many uses of *in*, such as “*in* a depression,” “*in* dire straits,” and “*in* a haze,” suggest low figure control and a negative outcome for the figure. As discussed earlier, there is a natural relationship between high control and a positive outcome for a figure: an agent who has a good deal of control is more likely to succeed in carrying out his/her intentions than one who does not. However, there are some cases for which the valence and control patterns separate. For example, the low figure control uses “*in* luck,” “*in* good hands,” and “*in* stitches” have a relatively positive valence, even though the figures do not have much control over their situations. Likewise, there are high-control uses that do not have a positive valence, such as “*on* guard,” “*on* the alert,” and “*on* the watch.” In these cases, the figures seem to have some control over a negative situation. For example, if someone is “*on* the alert,” this suggests that they are alarmed and prepared to take action against a threat. Overall, we observe that control and positive valence co-occur for many uses of *in* and *on*.

In this experiment, we collected only figure control ratings. Another way to assess relative control within the figure–ground relationship would be to collect ratings of ground control. According to our continuum of control account, the figure and ground control ratings should be reciprocal: If the figure has more control of the figure–ground relationship, then the ground necessarily has less. Thus, if we ask participants to rate ground control, the same pattern of findings should emerge—*in* grounds should be rated as having more control than *on* grounds. According to Garrod and Sanford’s proposal, both *in* and *on* should involve greater ground than figure control. Perhaps if people were asked to focus on ground control, they would classify both *in* and *on* as having high ground control. To test these two alternatives, in Experiment 1b we collected ground control ratings for the same sentences used in Experiment 1a. Our prediction is that figure *in* ground phrases would convey greater ground control than figure *on* ground phrases.

### 3. Experiment 1b

In Experiment 1b, we asked whether conventional abstract uses of *in* convey greater ground control than conventional abstract uses of *on*. We asked participants to rate the degree of ground control for the same figure *in* ground and figure *on* ground sentences used in Experiment 1a.

#### 3.1. Method

##### 3.1.1. Participants

Thirty-two participants (19 female,  $M_{\text{age}} = 20.25$ ) received payment for participation in this experiment. All were native speakers of English.

### 3.1.2. Materials

The materials were identical to those used in Experiment 1a except that the rating scale in Experiment 1b asked about ground control rather than about figure control. The scale ranged from 1 (*extremely low control of the person by the situation*) to 5 (*extremely high control of the person by the situation*).

### 3.1.3. Procedure

The procedure was identical to that in Experiment 1a, except that participants completed the ground control scale for each item.

## 3.2. Results

As predicted, we found that conventional abstract uses of *in* conveyed greater ground control than uses of *on*. Participants rated the situations in “figure *in* ground” sentences to have more ground control ( $M = 3.15$ ,  $SD = 0.31$ ) than situations in “figure *on* ground” sentences ( $M = 2.91$ ,  $SD = 0.44$ ),  $t(31) = 3.54$ ,  $p < .001$ ,  $d = 0.63$ . Item analyses revealed a similar pattern of results: Situations were rated as having more ground control in “figure *in* a ground” sentences ( $M = 3.14$ ,  $SD = 0.49$ ) than in “figure *on* a ground” sentences ( $M = 2.91$ ,  $SD = 0.51$ ),  $t(88) = 2.25$ ,  $p = .027$ ,  $d = 0.48$ .

## 3.3. Discussion

Bearing out the continuum of control account, in Experiments 1a and 1b we found that conventional abstract uses of *in* and *on* can be distinguished by the relative control of the figure–ground relationship. Further, the results are consistent with our second, more specific claim that *in* involves relatively greater ground control and that *on* involves relatively greater figure control. These results are also consistent with Garrod and Sanford’s (1989) proposal that abstract uses of *in* involve relatively greater ground than figure control (although not with their suggestion that the same is true for uses of *on*).

Overall, the findings of Experiments 1a and 1b are promising for the continuum of control account. However, there are some concerns. First, the figure *in* ground and figure *on* ground phrases used in the experiments did not use matched grounds. This had the advantage of allowing us to test highly typical and frequent uses (such as *in* the mood or *on* a roll). But it leaves open the possibility that people simply associate certain grounds (e.g., *on* a roll) with greater figure or ground control than other grounds (e.g., *in* the mood). If so, then the results could reflect these associations and not the abstract meanings of *in* and *on*. In order to test this possibility, in Experiment 2 we compared matched figure–ground pairs: for example, “Alexis has been *on* the job market for a week” versus “Lauren has been *in* the job market for a week.”

The second potential concern is that the use of a rating task may have made participants think explicitly about the issue of control. Because we are interested in their natural interpretations of the prepositions, in Experiment 2 we asked participants indirect questions that revealed which of two figures (the figure *in* ground or the figure *on* ground)

they thought had more control of a situation. If people simply associate certain grounds with either high or low figure control, then we should see no difference between the two prepositions in this study. However, if the continuum of control account is correct, then figures *on* ground will be chosen as having more control than figures *in* ground, even with identical grounds.

Because the results of Experiments 1ab showed similar patterns for ratings of figure control and ground control, in Experiment 2 and subsequent experiments we obtained measures of figure control.

## 4. Experiment 2

To test whether control can operate solely on the basis of the preposition (*in* vs. *on*), we gave participants phrases in which prepositions were matched with identical grounds and asked them questions that revealed which of the two figures had more (or less) control within the situation.

### 4.1. Method

#### 4.1.1. Participants

Thirty-two participants (23 female,  $M_{\text{age}} = 25.25$ ) received either partial course credit or payment for participation in this experiment. All were native speakers of English.

#### 4.1.2. Materials

Participants were presented with 14 sentence pairs—seven that contrasted the prepositions *in* and *on* and seven filler pairs that contrasted other words. As in Experiments 1ab, the materials involved conventional uses of *in* and *on*. Each sentence pair was followed by a forced-choice question phrased to correspond to the situation described by the sentences. For the seven preposition pairs, each of the corresponding forced-choice questions was designed to reveal which figure was perceived to have more (or less) control, as in the example below.

|   |                            |
|---|----------------------------|
| Alexis and Lauren are both unsatisfied with their current jobs and are looking for better ones. |                            |
| Alexis has been on the job  | Lauren has been in the job |
| market for a week   | market for a week          |
| Who is more likely to be able to find a good job?   |                            |
| Alexis  | Lauren                     |

The seven filler pairs followed a parallel structure but contrasted other word pairs. The corresponding questions asked which of two inferences was more (or less) likely. For example, one sentence pair described two children drinking iced tea: Susie sipped the iced tea and Kim gulped the iced tea. The question asked who would drink more (or less) iced tea.

As in Experiments 1a,b, the uses of *in* and *on* were chosen from idiom dictionaries and were selected if both the *in* and *on* use within a pair appeared in COCA. Naturalness ratings of the *in* and *on* sentences were collected in a separate test. Ten participants rated the naturalness of each sentence on a scale from 1 (*not at all natural*) to 9 (*very natural*). The *in* and *on* sentences did not differ in their naturalness,  $M_{in} = 6.66$ ,  $SD = 0.71$ ,  $M_{on} = 6.44$ ,  $SD = 1.24$ ,  $t(6) = 0.49$ ,  $p = .639$ ,  $d = 0.21$ .

The key design factors were preposition used (*in* vs. *on*) and question type (less vs. more control), both within-subjects. In addition, there were four between-subjects counterbalancing factors. The 14 sentence pairs were presented in one of two orders: Half of the forced-choice questions were phrased with *less* and half with *more* (i.e., Who is *less/more* likely to ...). For the seven preposition sentence pairs, the predicted answers were located on the left-hand side of the page either three or four times (out of seven) and were associated with the figure *in* ground either three or four times. Crossing these four factors resulted in 16 possible counterbalancing conditions. Two participants completed each of these counterbalancing conditions. All 32 participants received seven sentence pairs contrasting *in* and *on* and seven filler sentence pairs.

#### 4.1.3. Procedure

Participants read each of the 14 sentence pairs and answered a related forced-choice question about which of two choices was more (or less) likely. Following each question, participants rated their confidence on a scale from 1 (*not at all confident*) to 5 (*very confident*).

## 4.2. Results

As predicted, we found that figures *on* ground were perceived as having greater control than matched figures *in* ground. Overall, participants made more choices in the expected direction (i.e., choosing figures *on* a ground when asked which figure had more control and choosing figures *in* a ground when asked who had less control) ( $M = 4.56$ ,  $SD = 1.32$ ) than would be expected by chance,  $t(31) = 4.56$ ,  $p < .001$ ,  $d = 0.80$ . Participants were also more confident in expected choices ( $M = 3.43$ ,  $SD = 0.74$ ) than in choices made in the unexpected direction ( $M = 2.51$ ,  $SD = 1.10$ ),  $t(31) = 4.75$ ,  $p < .001$ ,  $d = 0.98$ . Participants were more likely to choose figures *on* a ground when asked which figure was *more* likely to control a situation ( $M = 0.66$ ,  $SD = 0.26$ ) than when asked which figure was *less* likely to control a situation ( $M = 0.33$ ,  $SD = 0.25$ ),  $t(31) = 4.87$ ,  $p < .001$ ,  $d = 1.29$ . See Fig. 1.

Item analyses revealed a similar pattern of results. The proportion of expected choices (i.e., choosing the figure *on* a ground when asked which figure had more control and choosing the figure *in* a ground when asked who had less control) ( $M = 0.65$ ,  $SD = 0.17$ ) was higher than would be expected by chance,  $t(6) = 2.33$ ,  $p = .029$ ,  $d = 0.88$ .

## 4.3. Discussion

The results of Experiment 2 suggest that people perceived figures *on* ground to have more control than figures *in* ground, even when the grounds were matched. It is also

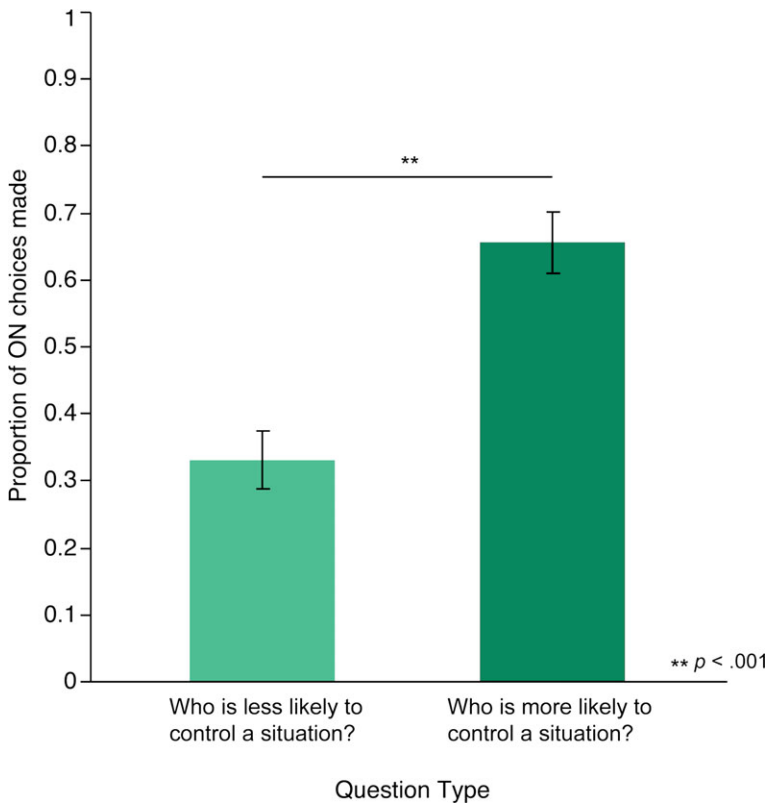


Fig. 1. Results of Experiment 2. Participants decided which of two figures (the figure *in* or *on* ground) had more (or less) control within different situations. Participants were more likely to choose figures *on* a ground when asked which figure was *more* likely to control a situation than when asked which figure was *less* likely to control a situation.

reassuring that the predicted pattern appears even for an indirect assessment of figure control. These findings provide additional evidence for the continuum of control account and suggest that the obtained differences in perceived control seen in Experiments 1ab stem from the prepositions *on* and *in*, rather than from their associated grounds.

A possible limitation of this first set of experiments is that all of the abstract uses of *in* and *on* we tested were conventional. Thus, it remains conceivable that people learned to associate particular abstract uses of *on* with greater figure control (and the reverse for *in*) on a case-by-case basis. In Experiments 3ab, we tested whether these patterns would generalize to novel abstract uses. For example, if the novel ground “cipe” is introduced, will a figure *on* a cipe be perceived as having more control than a figure *in* a cipe? If indeed this difference continues to hold, this will be evidence that the continuum of control aspect of *in* and *on* meaning is generalizable and will provide stronger evidence for relative control in the interpretation of abstract *in* and *on*.

## 5. Experiment 3a

To test whether the continuum of control is carried forward to novel abstract uses of *in* and *on*, in Experiment 3a we asked participants to interpret sentences describing figures *in* or *on* a novel ground. Participants were presented with contexts in which novel words could be used and were given a description of a figure from this context described as *in* or *on* a novel ground. They were then asked to interpret sentences containing these novel uses. We predicted that participants would construe figures *on* ground as having more control than figures *in* ground.

### 5.1. Method

#### 5.1.1. Participants

Sixteen participants (10 female,  $M_{\text{age}} = 19.00$ ) received either partial course credit or payment for participation in this experiment. All were native speakers of English.

#### 5.1.2. Materials

Participants were presented with 16 passages that involved activities that could be described with a novel “niche” vocabulary. Each situation was described with an introductory paragraph that was followed by a target sentence describing a figure from the situation that included a novel word (a plausible non-word from the ARC Nonword Database; Rastle, Harrington, & Coltheart, 2002). There were eight experimental passages, whose key sentence included *in* or *on* paired with a novel ground. The novel word was always used as a noun—for example, “We let Matt decide where to set up the nets last week and he seemed to be *in* a *thrig*.” To disguise the purpose of the task, the key passages were interspersed with eight filler passages, whose key sentence included a novel word playing the role of a verb, adjective, or noun (e.g., “Tim is trying to convince me to plant mustard plants on the farm, but I think it would *thafe* the honey”).

An example passage is given below. The participants’ task was to interpret the final sentence describing the figure.

Context: Kate is a perfume maker who is very skilled at discovering new scent combinations. She works for a perfume company that creates unusual fragrances made from rare plant oils. Kate creates new scents for the company. The process of mixing the plant oils is very complicated. Kate has good days, when the scents she creates are subtle and intricate, and bad days, when her nose seems insensitive and the scents she creates are boring.

Transcript from Tracy (a worker in the perfume company): “It’s the third day of the mixing process and Kate is in a cipe” (or “on a cipe” in the other version).

What does the transcript sentence mean?

The key design factor (within-subjects) was whether *in* or *on* was used in the figure description. In addition, there were three between-subjects counterbalancing factors. The 16 passages were presented in one of two orders. Each of the 16 target sentences contained one of two plausible non-words. Each of the eight test sentences contained either *in* or *on*. Crossing these three factors resulted in eight possible counterbalancing conditions. Two participants completed each of these counterbalancing conditions. All participants read and interpreted eight passages involving *in* and *on* and eight filler passages.

### 5.1.3. Procedure

Participants were instructed to imagine that they were reading transcripts from anthropological observations. They were asked to read each description of the transcript context and the transcript sentence, and then to write down their interpretation of the transcript sentence.

Interpretations consisting of one word or uninterpretable fragments were excluded from further coding (6 out of 128 interpretations were excluded). Two trained undergraduate research assistants, who were blind to condition, coded participant interpretations for figure control. For each of the eight test items, the coders read the context descriptions (but not the transcript sentences containing the key prepositions). With that context provided, the coders rated participants' interpretations for figure control on a scale from 1 (*extremely low control of the situation by the person*) to 5 (*extremely high control of the situation by the person*).

## 5.2. Results

Consistent with our predictions, when interpreting novel abstract uses of *in* and *on*, participants construed figures *on* ground as having more control than figures *in* ground. Interpretations of figures *on* ground were rated as having more control ( $M = 3.45$ ,  $SD = 0.32$ ) than interpretations of figures *in* ground ( $M = 2.84$ ,  $SD = 0.56$ ),  $t(15) = 3.31$ ,  $p = .005$ ,  $d = 1.34$ , with inter-rater reliability of  $r = .677$ ,  $p < .001$ . The prepositions influenced interpretations of novel nouns with which they were paired. As an example, participants who read that Kate, the perfumer, was *in a cipe* gave interpretations such as: "Kate is having problems with her new perfume she's making" and "Kate isn't doing so well finding the perfect scent." In contrast, those who had read that Kate was *on a cipe* gave interpretations such as: "She is creating a good scent today" and "Kate is doing well. Tracy [another worker at the factory] wishes she were like Kate."

As these examples show, participants' interpretations often related figure control and success. This makes sense, given the earlier discussion about the natural relationship between control and likelihood of success. Nevertheless, some of the interpretations did dissociate the two. For example, interpretations that described figures as "lucky" were not given high figure control ratings because the figures' success did not seem to stem from their control of the situation.

Item analyses revealed a similar pattern of results. Interpretations of figure *on* ground sentences were rated as having greater figure control ( $M = 3.44$ ,  $SD = 0.46$ ) than



interpretations of the corresponding figure *in* ground sentences ( $M = 2.84$ ,  $SD = 0.47$ ),  $t(7) = 5.27$ ,  $p = .001$ ,  $d = 1.28$ .

### 5.3. Discussion

In Experiment 3a, we tested whether the relative control aspect of *in* and *on* meaning is generalizable, that is, whether it can be extended to novel uses of these prepositions. As predicted, we found that figures *on* a novel ground were construed as having more control than figures *in* a novel ground.

This pattern of results could have come about in two ways. One possibility is that participants interpreted novel uses through local analogical extensions from particular conventional uses, as has been proposed for novel extensions of verb constructions (e.g., Bybee & Eddington, 2006). For example, the novel phrase “*on* a cipe” might have reminded participants of the frequent familiar phrase “*on* a roll.” Based on the phrases’ similarity, participants could have inferred that like a figure *on* a roll, a figure *on* a cipe should have relatively high control. If this is the case, people should be more likely to correctly interpret a novel use if it is similar to a frequent familiar phrase.

Another possibility is that people have abstracted and stored a general relative control schema (perhaps through repeated analogical extensions over varied uses of *in* and *on*; see Wolff & Gentner, 2011). In this case, people should be able to apply the relative control schema regardless of whether the novel uses are similar to particularly frequent *in* and *on* phrases.

In order to test these two possibilities, in Experiment 3b, we altered the novel phrases to render them less similar to frequent *in* and *on* phrases. To do this, we inserted an adjective between the preposition and the ground (e.g., *on* an extreme grore). These constructions are relatively infrequent<sup>6</sup> and should be less likely to remind participants of common familiar phrases.

If relative control is invoked in the comprehension of novel abstract uses of *in* and *on*, then participants in Experiment 3b should interpret novel figures *on* ground as having greater control than figures *in* ground, despite there being minimal similarity to conventional phrases.

## 6. Experiment 3b

The methods of Experiment 3b were identical to those of Experiment 3a except for the insertion of modifiers into each of the key sentences.

### 6.1. Method

#### 6.1.1. Participants

Thirty-two participants (22 female,  $M_{\text{age}} = 19.97$ ) received either partial course credit or payment for participation in this experiment. All were native speakers of English.

### 6.1.2. Materials

Modifiers were inserted into each of the key sentences used in Experiment 3a. For the eight test sentences (those that included *in* and *on*), adjectives were inserted between the prepositions and novel words to form prepositional phrases of the form “in/on a(n) modifier novel word” (e.g., It’s the third day of the mixing process and Kate is in an absolute cipe).<sup>7</sup> For the eight filler sentences, modifiers were likewise inserted immediately before the novel words.

The key within-subjects factor was whether *in* or *on* was used in the figure description passage. Along with counterbalancing the order of sentence presentation, the assignment of non-words, and the assignment of prepositions, as in Experiment 3a, in Experiment 3b the assignment of modifiers to the test sentences was counterbalanced so that each test sentence contained one of two possible modifiers. This resulted in four between-subjects counterbalancing factors, with sixteen possible combinations of these factors. As before, two participants completed each of the possible counterbalancing conditions.

### 6.1.3. Procedure

The procedure was identical to that of Experiment 3a. The procedure for coders was also identical to that of Experiment 3a. One of the coders had participated in coding for Experiment 3a and one coder was new and trained to complete the task. Both coders were blind to condition. Interpretations consisting of one word or uninterpretable fragments were excluded from coding (9 out of 256 interpretations were excluded).

## 6.2. Results

As predicted, participants’ interpretations of figures *on* ground were rated as having more control ( $M = 3.34$ ,  $SD = 0.63$ ) than their interpretations of figures *in* a ground ( $M = 2.48$ ,  $SD = 0.52$ ),  $t(31) = 5.29$ ,  $p < .001$ ,  $d = 1.47$ , with inter-rater reliability of  $r = .779$ ,  $p < .001$ . Examples of participants’ interpretations are presented in Table 1.

Item analyses revealed a similar pattern of results. Interpretations of figure *on* ground sentences were rated as having greater figure control ( $M = 3.38$ ,  $SD = 0.56$ ) than interpretations of the corresponding figure *in* ground sentences ( $M = 2.49$ ,  $SD = 0.36$ ),  $t(7) = 4.28$ ,  $p = .004$ ,  $d = 1.88$ .

To assess the possibility that participants completed the task by substituting novel *in* and *on* uses with existing conventional uses like “*in* a frenzy” or “*on* a roll,” we examined how often participants described a figure *in* a novel ground as *in* a ground in their interpretations, or a figure *on* a novel ground as *on* a ground (e.g., describing a figure “*in* an absolute cipe” as “*in* a low point” or a figure “*on* an absolute cipe” as “*on* a roll”). In total, there were 53 of these cases, 31 for *in* and 22 for *on*. Removing these cases from the analyses yielded the same pattern of results: Participants’<sup>8</sup> interpretations of figures *on* ground were rated as having more control ( $M = 3.17$ ,  $SD = 0.76$ ) than their interpretations of figures *in* a ground ( $M = 2.38$ ,  $SD = 0.62$ ),  $t(30) = 4.21$ ,  $p < .001$ ,  $d = 1.14$ . Likewise, the pattern of results for the item analysis remained the same: Interpretations of figure *on* ground sentences were rated as having greater figure control ( $M = 3.31$ ,

Table 1

An example passage from Experiment 3b and sample interpretations of a figure *in* or *on* a novel ground given by participants

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Test passage example

Context: A group of shrimp fishermen gather at a popular bay each season. A limited number of boats are allowed in the water, so there are usually several fishermen per boat. As a group, they decide where to fish before setting up their equipment. They have to identify a location where the waters will be warm enough to support the shrimp colonies but cool enough near the surface so that the shrimp will be within reach of their nets.

Transcript sentence from Steve (a shrimp fisherman): “*We let Matt decide where to set up the nets last week and he seemed to be in/on a (modifier) (novel word)*”

Sample participant responses for: “. . . *he seemed to be in a (modifier) (novel word)*.”

“Matt was very confused as to where to set up the nets.”

“Matt was possessed by the idea of catching as many shrimp as possible, to the degree that he kept deciding to change the fishing locations often and randomly, much to the dismay of everyone else.”

“Matt was nervous about setting up the nets.”

Sample participant responses for: “. . . *he seemed to be on a (modifier) (novel word)*.”

“Matt decided where to set up the nets and he did a good job because a lot of shrimp were caught, so they’re going to let Matt choose the location again.”

“Matt picked several suitable locations in a row last week.”

“He was very happy about getting to make decisions for the group and took advantage of his control.”

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$SD = 0.54$ ) than interpretations of the corresponding figure *in* ground sentences ( $M = 2.45$ ,  $SD = .40$ ),  $t(7) = 3.66$ ,  $p = .008$ ,  $d = 1.81$ .

### 6.3. Discussion

Extending the findings of Experiment 3a, in Experiment 3b we found that figures *on* a novel ground were construed as having more control than figures *in* a novel ground even when modifiers were added between the prepositions and the novel grounds. Thus, it is unlikely that novel uses of *in* and *on* (e.g., *in* or *on* a pipe) are understood through their similarity to particular frequent conventional uses. Instead, this pattern suggests that the relative control aspect of preposition meaning is broadly extended to the comprehension of novel uses, regardless of local similarity to existing uses—consistent with there being a general abstract schema.

Together, the results of Experiments 3ab suggest that the control aspect of preposition meaning is broadly generalizable and can be carried forward to the comprehension of novel abstract uses of *in* and *on*. Next, we ask whether this aspect of meaning can also be extended to the production of novel abstract uses.

In the first three sets of experiments, we tested whether control is involved in the comprehension of *in* and *on*, addressing what has previously been called the *decoding problem* in the preposition literature (e.g., Coventry & Garrod, 2004; Coventry et al., 1994). In Experiment 4, we address the *encoding problem*—given a relationship between a figure and ground, we ask people to predict what preposition should be used to describe it.

Specifically, we ask whether people adapt which preposition they use to describe a figure depending on whether the figure is portrayed as having low or high control of a situation.

## 7. Experiment 4

In Experiment 4, we tested whether the control aspect of meaning can be extended to the production of novel uses of *in* and *on*. Adapting the materials from Experiment 3a, we gave participants descriptions of figures portrayed as having either low or high control of a situation and asked them to choose whether the figure would be best described as *in* or *on* a novel ground. We predicted that participants would describe high-control figures as *on* a ground and low-control figures as *in* a ground.

### 7.1. Method

#### 7.1.1. Participants

Thirty-two participants (17 female,  $M_{\text{age}} = 20.25$ ) received either partial course credit or payment for participation in this experiment. All were native speakers of English.

#### 7.1.2. Materials

The experimental materials were adapted from Experiment 3a. For the eight test passages, each description of the situation was followed by a description of a figure that either had high or low control within that situation (high-control figure vs. low-control figure). Following this, a sentence described the figure as “\_\_\_\_\_ a novel ground,” and participants were given a choice to fill in the blank with either *in* or *on* (question wording: “What word is missing? Circle one”). An example of a high-control figure description and a low-control figure description are presented below.

Context: Kate is a perfume maker who is very skilled at discovering new scent combinations. She works for a perfume company that creates unusual fragrances made from rare plant oils. Kate creates new scents for the company. The process of mixing the plant oils is very complicated. Kate has good days, when the scents she creates are subtle and intricate, and bad days, when her nose seems insensitive and the scents she creates are boring.

[High-control figure] Yesterday Kate was very well rested and her sense of smell was very sharp. She was easily discriminating between the different smells and picking up the subtle scents in the plant oils.

[Low-control figure] Yesterday Kate had a cold and she was sniffing throughout the day. She was having trouble discriminating between the different smells and picking up the subtle scents in the plant oils.

Kate was \_\_\_\_\_ a tem during the mixing process.

What word is missing? Circle one: in on

We collected figure control ratings of the high-control and low-control versions of the figure descriptions in a separate test. Twenty participants read four high-control descriptions, four low-control descriptions, and four filler passages (with high-control/low-control versions of the passages and the order of items counterbalanced between-subjects), and rated the control of the figure described by each passage on a scale from 1 (*extremely low control of the situation by the person*) to 5 (*extremely high control of the situation by the person*). As expected, high-control versions of the figure descriptions were rated higher in control ( $M = 3.85$ ,  $SD = 0.40$ ) than the low-control versions ( $M = 2.38$ ,  $SD = .48$ ),  $t(7) = 7.13$ ,  $p < .001$ ,  $d = 3.34$ .

As in earlier experiments, we included eight filler passages to disguise the purpose of the task. Each of the filler passages was composed of a paragraph-long description of a situation and information about characters in that situation. As in the test passages, the final sentence of the filler passages contained a novel word and a blank for participants to fill in with one of two words (e.g., It was clear that Adam's new technique was very [inventive/commonplace] because he made plastic that could be strinched).

The key design factor (within-subjects) was whether figures were portrayed as having high or low control of the situation. In addition, there were three between-subjects counterbalancing factors. The 16 passages were presented in one of two orders. Each of the 16 target sentences contained one of two plausible non-words. One half or the other half of the eight test passages portrayed the figure as having high control of the situation. Finally, each of the word choices was presented on the left and the right equally often in the question that followed each target sentence. Crossing these four factors resulted in 16 possible counterbalancing conditions. As before, two participants completed each of these conditions. All participants received eight test passages and eight filler passages.

### 7.1.3. Procedure

As in Experiment 3a, participants were asked to imagine that they were reading fragments of transcripts from collected anthropological observations along with their contexts. They were asked to read the transcript fragments and to fill in what they believed to be the missing word in each of the transcripts.

## 7.2. Results

As predicted, participants were more likely to describe high-control figures as *on* a ground and low-control figures as *in* a ground. Overall, participants made more choices in this expected direction ( $M = 5.34$ ,  $SD = 1.45$ ) than would be expected by chance  $t(31) = 5.24$ ,  $p < .001$ ,  $d = 0.92$ . Participants were more likely to label figures *on* a ground when the figures had been described as having high control ( $M = 0.56$ ,  $SD = 0.26$ ) than when the figures had been described as having low control ( $M = 0.23$ ,  $SD = 0.22$ ),  $t(31) = 5.24$ ,  $p < .001$ ,  $d = 1.38$ . Interestingly, across conditions, participants were significantly more likely than chance to label figures as *in* a ground ( $M = 0.60$ ,  $SD = 0.16$ ),  $t(31) = 3.68$ ,  $p < .001$ ,  $d = 0.65$ , possibly due to the greater natural frequency of *in*.<sup>9</sup>

Item analyses revealed a similar pattern of results. The proportion of expected descriptions (i.e., high-control figures described as *on* a ground and low-control figures described as *in* a ground) ( $M = 0.67$ ,  $SD = 0.08$ ) was higher than would be expected by chance,  $t(7) = 6.07$ ,  $p < .001$ ,  $d = 2.15$ .

### 7.3. Discussion

In Experiment 4, we tested whether the control aspect of meaning can be carried forward to the production of novel abstract uses of *in* and *on*. As predicted, we found that the extent to which a figure controls a situation influences whether the figure is labeled *in* or *on* a novel ground. Together with the findings of Experiments 3ab, the findings of Experiment 4 suggest that the control aspect of *in* and *on* meaning is broadly generalizable, both in comprehension and production.

## 8. General discussion

We proposed the continuum of control account in which abstract uses of *in* and *on* are distinguished by the relative control of the figure–ground relationship. Our evidence bears out this account. The extent to which the figure versus the ground controls the figure–ground relationship differentiates abstract uses of *in* and *on*, as it does concrete spatial uses of these prepositions. We also found evidence for the more specific claim that *on* conveys relatively greater figure control and that *in* conveys relatively greater ground control.

In Experiments 1ab, we tested whether relative control can differentiate conventional abstract uses of *in* and *on* such as “Casey is *in* a hurry” and “Jessie is *on* a roll.” We found that *on* conveyed greater figure control than *in*, and that *in* conveyed greater ground control than *on*. In Experiment 2, we found that this effect holds also when comparing phrases with matched abstract grounds, as in “*on* the job market” versus “*in* the job market.” Extending the findings from Experiments 1ab, we found that figures *on* a ground were perceived as having more control than figures *in* that ground. Thus, Experiments 1ab and 2 provide evidence that relative control differentiates existing abstract uses of *in* and *on*.

In Experiments 3ab and 4, we went beyond characterizing conventional abstract uses; we asked whether the difference in relative control between *in* and *on* is generalizable to novel uses. These studies also tested whether the patterns of relative control hold up for more implicit measures of perceived control. In Experiments 3ab, we tested whether relative control can be extended to understand novel pairings of *in* and *on* with abstract grounds (e.g., a figure *in/on* a pipe). We found that the preposition used to connect a figure–ground pair influenced participants’ interpretations of control within the figure–ground relationship: figures described as *on* a novel ground were construed as having more control than figures *in* a novel ground. For example, participants who read that Kate, a perfumer, was *on* a pipe gave interpretations such as “She is creating a good scent

today,” but participants who read that Kate was *in* a cipe gave interpretations such as “Kate isn’t doing so well finding the perfect scent.” As is the case in these examples, figure control and valence were often related in participants’ interpretations: High control was often linked to a positive outcome and low control to a negative outcome. While valence and control are clearly distinct theoretical dimensions, in practice they are positively correlated: If an agent has a great deal of control, he or she is likely to succeed in carrying out his/her intentions (leading to a positive outcome), and if they have little control, he or she is likely to fail in carrying these intentions (leading to a negative outcome). Though control and valence can be separated, it is beyond the scope of this paper to fully disentangle the respective relationships of control and valence with the prepositions under investigation.

In Experiment 4, we asked whether relative control is likewise generalizable in the production of prepositions. Specifically, we asked whether the extent to which a figure controls a situation influences whether the figure will be described as *in* or *on* a novel ground. We found that preposition choice was influenced by figure control: Figures described as having high control were more likely to be labeled *on* a novel ground than figures described as having low control. Together, these findings suggest that a continuum of control distinguishes abstract uses of *in* and *on*, and that this aspect of meaning can be extended to novel uses.

### 8.1. Relation of findings to previous accounts of abstract uses of prepositions

The continuum of control account and our current findings can be related to previous accounts that posited general differences between abstract uses of *in* and *on* (Evans, 2010; Garrod & Sanford, 1989). As outlined earlier, the continuum of control account is most similar to Garrod and Sanford’s (1989) proposal that spatial and abstract uses of *in* and *on* both convey greater ground control than figure control, differing only in the extent of the ground advantage. The results of Experiments 1ab indicate a more specific difference: *in* conveys greater ground control (as in Garrod and Sanford’s account), but *on* conveys greater figure control. Still, our findings agree with the main feature of Garrod and Sanford’s proposal—the centrality of relative control for abstract uses of *in* and *on*.

We can also compare our findings to Evans’s (2010) proposal that abstract uses of *on* (e.g., *on* fire, *on* sale) derive from a functional actioning parameter. This parameter involves a figure becoming active as a consequence of contact with the ground. The figure’s active state is limited in time, since the figure will only be active as long as it is in contact with the ground. In our studies, we find some abstract uses of *on* that seem to fit this pattern (e.g., Dan remains *on* Lucy’s mind after their breakup), as well as others that do not (e.g., Louis runs a business and he is *on* the money). We suggest that the duration of the figure–ground relationship may be influenced by other contextual factors.

By focusing on differences between individual uses of *in* and *on*, other previous accounts (e.g., Beitel et al., 2001; Navarro i Ferrando, 1999, 2000) may capture some subtle aspects of meaning that are not fully explained by a general difference in relative

control between the prepositions. For example, Beitel et al. (2001) argued that abstract uses of *on* draw on one or more spatial schemas (*support, pressure, constraint, covering, visibility*). Though the *constraint* schema involves relative degree of figure and ground control, the other schemas do not, and abstract uses that draw primarily on those schemas should not evoke relative control. Likewise, Navarro i Ferrando (1999, 2000) posited several different kinds of spatial schemas for uses of *in* and *on*. On this account, abstract uses that derive from the support, enclosure, or functional spatial schemas could suggest a difference in relative control, but those uses that derive from the other schemas should not. This account overlaps only partially with our proposal, but we were able to compare our findings with the account's predictions for some abstract uses of *in* and *on*. We did not observe the pattern of results that would be predicted by the account.<sup>10</sup> However, it remains possible that further studies might reveal subtle nuances suggested by individual abstract uses of *in* and *on*. Next, we explore how the regularities in spatial and abstract preposition meanings might have developed.

### 8.2. *How might abstraction of preposition meaning occur over time?*

The Career of Metaphor hypothesis (Bowdle & Gentner, 1999, 2005; Gentner, Bowdle, Wolff, & Boronat, 2001; Gentner & Wolff, 1997) suggests a possible mechanism through which preposition meanings could have become abstracted while retaining aspects of spatial meaning. According to this account, when a term is used in a novel metaphoric way, the use can be processed by aligning the target and the base of the metaphor and abstracting their common structure. If an alignment between a target and base is consistently repeated, the structure abstracted through this alignment may become another conventional meaning of the base term.

Perhaps the meanings of *in* and *on* may have become abstracted through a similar process. If the prepositions were initially used in concrete settings such as “*in* a box” or “*on* the floor,” upon encountering an abstract extension such as “*in* my mind,” the base (i.e., the concrete meaning of the preposition derived from the many previously encountered concrete spatial uses) could be aligned with the target (the more abstract use). The alignment should result in the abstraction of their common structure, which would lack a concrete containment relation but could retain the control relation. Over time, this abstraction could come to serve as a secondary meaning of *in*. This more abstract meaning could then be applied across a variety of contexts while still retaining aspects of the preposition's spatial meaning. Such an abstraction process is also consistent with accounts of grammaticalization by typologists (e.g., Bybee, Perkins, & Pagliuca, 1994; Heine, Claudi, & Hünemeyer, 1991; Hopper & Traugott, 2003; Sweetser, 1990).

### 8.3. *Application to second language learning*

Learning the meanings of English prepositions is very challenging for second language speakers (e.g., Ijaz, 1986). Students are often told that abstract uses of prepositions are idiomatic, and are advised to memorize uses on a case-by-case basis (e.g.,



Yates, 1999). Teacher feedback can also reinforce the idea that there are no patterns to abstract preposition use. Students' errors related to prepositions can be considered "untreatable" since they cannot be avoided or fixed by referring to a specific set of rules (Ferris, 1999, 2003). When teachers encounter these kinds of errors in student writing, they are likely to address them by supplying the correct linguistic form (Ferris, 2006), instead of (for example) simply circling the incorrect form and inviting the students to apply their knowledge of prepositions' regular patterns. This kind of feedback may reinforce the idea that case-by-case memorization of preposition uses is required.

The current finding that many abstract uses of *in* and *on* can be distinguished by a continuum of control offers hope that there may be an alternative way for students to master frequent abstract uses of these prepositions. We are currently exploring whether teaching the notion of continuum of control can help students to become aware of the pattern among abstract uses (Tenbrink, Jamrozik, & Gentner, 2012).

#### 8.4. Conclusions

Prepositions seem effortless for speakers but they pose a challenge to semantic and computational accounts of language use—and abstract *in* and *on* have been among the most challenging. Our findings suggest that although abstract uses of *in* and *on* seem quite varied there is an important regularity governing their interpretations—the idea of a continuum of control. Like spatial uses of these prepositions, abstract uses of *in* involve relatively greater ground control of the figure–ground relationship and uses of *on* involve relatively greater figure control of the relationship. We found that this distinction holds for conventional abstract uses of *in* and *on*, and that it carries forward to the comprehension and production of novel abstract uses. In sum, despite the apparent heterogeneity of abstract uses of *in* and *on*, there appears to be a subtle but pervasive mapping from concrete spatial uses to these abstract uses.

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#### Notes

1. The issue of figure and ground control has not been central in distinguishing other pairs of prepositions. However, it has been suggested that *over* involves a degree

of figure control (e.g., Jane has a strange power *over* him) (e.g., Brugman, 1988; Brugman & Lakoff, 1988; Tyler & Evans, 2001) and that *over* and *under* are more sensitive to functional relations (the more general class of relations that includes control) than *above* and *below* (Coventry, Prat-Sala, & Richards, 2001).

2. Vandeloise's account concerned the equivalent French prepositions *dans* and *sur*.
3. This account only dealt with abstract uses of *on*.
4. The names were chosen from social security records of American children born between 1992 and 1995 (roughly corresponding to the ages of most participants). Names were considered gender ambiguous if they were among the top 1,000 names given to males and females. Gender ambiguous names were used to minimize the likelihood that participants would use figure gender instead of the prepositional phrase to make figure control ratings.
5. *T*-tests and computation of the *d* statistic were performed using log frequencies.
6. Based on data from COCA (Davies, 2008), the frequency of prepositional phrases made up of *in* or *on*, a determiner, and a noun phrase is eight times higher than that of phrases made up of *in* or *on*, a determiner, an adjective, and a noun phrase.
7. To ensure that phrases with modifiers were less frequent than those without modifiers—and so presumably less retrievable—we selected four representative phrases from Experiment 1a (*in* a haze, *in* a depression, *on* a roll, *on* a mission) and calculated how frequently they occur with the modifiers used in Experiment 3b. The four unmodified phrases appeared in COCA 1,686 times and only appeared with any of the modifiers five times, suggesting that adding modifiers into the novel phrases made typical *in* and *on* phrases less retrievable.
8. One participant's data had to be removed from the analysis because every figure *in* a novel ground was described with an *in* ground phrase.
9. *In* is 2.78 times more frequent than *on* (frequencies from COCA; Davies, 2008).
10. We were able to classify 18 expressions as deriving from one of the schemas proposed by Navarro i Ferrando (*in* mind, *in* time, *in* good hands, *in* a rush, *in* the wrong, *in* a hurry, *in* the mood, *in* stride, *in* style, *on* time, *on* schedule, *on* the alert, *on* the lookout, *on* active duty, *on* guard, *on* the run, *on* edge, and *on* trial). Eight of these expressions fit Navarro i Ferrando's predicted pattern, six expressions showed the opposite pattern, and four showed a mixed pattern.

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### Supporting Information

Additional Supporting Information may be found in the online version of this article:

Data: Average figure control ratings for figures paired with *in* phrases and *on* phrases in Experiment 1a.

#### Appendix A: Average figure control ratings for figures paired with *in* phrases and *on* phrases in Experiment 1a.

| <i>In</i> Phrases   | Avg. Control Rating | <i>On</i> Phrases   | Avg. Control Rating |
|---------------------|---------------------|---------------------|---------------------|
| In shape            | 4.41                | On top of it        | 4.31                |
| In action           | 4.03                | On schedule         | 4.31                |
| In the zone         | 4.03                | On top of the world | 4.22                |
| In the loop         | 3.97                | On the money        | 4.16                |
| In tune             | 3.91                | On the offensive    | 4.09                |
| In style            | 3.91                | On a roll           | 4.09                |
| In character        | 3.88                | On the ball         | 4.00                |
| In the know         | 3.87                | On target           | 4.00                |
| In step             | 3.81                | On a mission        | 3.97                |
| In fashion          | 3.75                | On task             | 3.91                |
| In the groove       | 3.69                | On track            | 3.88                |
| In the mood         | 3.69                | On the alert        | 3.84                |
| In stride           | 3.69                | On the project      | 3.81                |
| In the clear        | 3.69                | On the go           | 3.81                |
| In gear             | 3.69                | On the mark         | 3.81                |
| In the running      | 3.53                | On the case         | 3.81                |
| In the market       | 3.53                | On the move         | 3.69                |
| In check            | 3.22                | On the lookout      | 3.69                |
| In the line of duty | 3.06                | On the watch        | 3.69                |
| In the job market   | 3.03                | On the safe side    | 3.66                |
| In luck             | 2.84                | On active duty      | 3.66                |
| In a hurry          | 2.78                | On the prowl        | 3.52                |
| In the same boat    | 2.72                | On the town         | 3.50                |
| In a rush           | 2.72                | On guard            | 3.50                |
| In good hands       | 2.66                | On strike           | 3.47                |
| In a huff           | 2.59                | On the wagon        | 3.47                |
| In a funk           | 2.31                | On a pedestal       | 3.34                |
| In hot water        | 2.25                | On an even keel     | 3.25                |
| In a quandary       | 2.25                | On the fly          | 3.16                |
| In stitches         | 2.25                | On the rebound      | 3.06                |
| In the wrong        | 2.22                | On the mend         | 3.03                |
| In the gutter       | 2.18                | On the fence        | 2.84                |

(continued)

## Appendix A (continued)

| <i>In</i> Phrases | Avg. Control Rating | <i>On</i> Phrases     | Avg. Control Rating |
|-------------------|---------------------|-----------------------|---------------------|
| In a hole         | 2.16                | On the defensive      | 2.81                |
| In limbo          | 2.09                | On the loose          | 2.69                |
| In a rut          | 2.09                | On the run            | 2.66                |
| In tears          | 2.09                | On a rampage          | 2.63                |
| In deep water     | 2.03                | On edge               | 2.59                |
| In the hot seat   | 2.03                | On the hook           | 2.53                |
| In a bind         | 1.97                | On the ropes          | 2.53                |
| In a fog          | 1.97                | On welfare            | 2.19                |
| In a cold sweat   | 1.91                | On trial              | 1.97                |
| In a bad way      | 1.91                | On pins and needles   | 1.97                |
| In a haze         | 1.84                | On thin ice           | 1.91                |
| In dire straits   | 1.78                | On the chopping block | 1.84                |
| In a depression   | 1.59                | On a slippery slope   | 1.78                |