



Five on one side: Personal and social information in spatial choice



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ABSTRACT

To examine whether the outcome of a rat's own choices ("personal information") and the choice behavior of another rat ("social information") can jointly control spatial choices, rats were tested in an open field task in which they searched for food. For the rats of primary interest (Subject Rats), the baited locations were all on one side of the arena, but the specific locations baited and the side on which they occurred varied over trials. The Subject Rats were sometimes tested together with an informed "Model" rat that had learned to find food in the same five locations (all on the same side of the arena) on every trial. Unintended perceptual cues apparently controlled spatial choices at first, but when perceptual cues to food location were not available, choices were controlled by both personal information (allowing the baited side of the arena to be determined) and social information (allowing baited locations to be determined more precisely). This shows that control by personal and social information are not mutually exclusive and supports the view that these two kinds of information can be used flexibly and adaptively to guide spatial choices.

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1. Introduction

1.1. Theoretical background

Animals acquire information about their world from several kinds of sources. The sources that have received the most attention in psychological studies of learning involve exposure to contingencies among events in the world and contingencies between the animal's own behavior and the outcome of that behavior. The processes corresponding to these two kinds of contingencies are typically understood to be classical and instrumental learning, respectively (e.g., Dickinson, 1980). For present purposes, an important property of these sources of information is that they are based on the individual experience of the animal.

Animals also acquire information from other animals (typically, conspecifics), apparently taking advantage of information acquired directly by others. A wide range of social learning phenomena have been studied during the past few decades, using a variety of species and from a variety of theoretical perspectives (e.g., Box and Gibson, 1999; Byrne and Whiten, 1988; Giraldeau and Caraco, 2000; Heyes and Galef, 1996; Zentall and Galef, 1988). In princi-

ple, socially acquired information has the advantage of allowing contingencies to influence behavior adaptively without having to experience them directly, but rather by taking advantage of the experiences of other animals (Danchin et al., 2004; Templeton and Giraldeau, 1996). The focus of the experiment reported here is the distinction between information that an animal acquires directly from its own experience with the environment ("personal information") and social information that an animal acquires from another animal (Templeton and Giraldeau, 1996; Valone and Templeton, 2002).

1.2. Empirical background

Previous work from our laboratory has examined social influence, social learning and social memory in two similar laboratory spatial search tasks. First, when two rats are tested together in the radial-arm maze, they are influenced by two countervailing social influences (Brown, 2011; Brown et al., 2008, 2007, 2009). On the one hand, they tend to approach a familiar (cage mate) conspecific and (perhaps as a result) choose maze locations in which the other rat is present. On the other hand, they avoid choice of maze locations that were visited by the other rat earlier during the trial (and thereby depleted of food). The latter tendency persists over short delays during which any odor cues left by the other rat are rendered irrelevant (Brown et al., 2007). It is also modulated by both the qual-

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ity and quantity of food present following a visit by the other rat. Specifically, if locations contain large caches of food not depleted when a rat chooses the maze location, then previous visits by the other rat either increase or decrease the tendency to choose that location, depending on whether the food is a relatively more preferred or less preferred food type (Brown et al., 2008). Furthermore, the quantity of food available in locations also modulates the social effect; previous visits by the other rat either decrease or increase the tendency to choose a maze location, depending on whether the quantity of food there is such that it was or was not depleted by the other rat's visit, respectively. Thus, social information appears to increase choice efficiency by guiding rats to locations more likely to contain food or relatively preferred food.

More recently, work from our laboratory has examined social influences on spatial choices made in an open field task with a matrix of discreet choice locations, known as the Pit Maze (Bisbing, 2015; Keller and Brown, 2011). The apparatus consists of a 5×5 matrix of locations ("pits") in which food can be hidden under covers that must be lifted by the rat to determine whether food is available in the location. Keller and Brown (2011) tested pairs of rats in the Pit Maze in trials that started with all 25 pits baited with a single, small food pellet. Under these conditions, rats tended to avoid visits to locations that had been previously visited (and thereby depleted of food) by the other rat, just as they do in the radial-arm maze.

Bisbing et al. (2015) reported four experiments using the Pit Maze. All of them involved a procedure in which only a subset of the 25 locations was baited on each trial. In addition, some trials involved testing two rats together. One of the two rats (referred to as the "Model Rat") had consistently experienced the same subset of locations being baited over trials. The other rat ("Subject Rat") had experienced different subsets of baited locations over trials. Thus, the Model Rat potentially provided social information to the Subject Rat about the locations of food during a particular trial and the key question was the extent to which this information controlled the choices made by the Subject Rats. When all of the pits on one side of the arena were baited with a single food pellet and the pits on the other side of the arena were not baited (Bisbing et al., 2015, Experiments 1 and 2), Model Rats quickly learned to restrict their choices to the pits on the baited side of the arena. Subject Rats, for which the baited side of the arena varied unpredictably, quickly learned to locate the baited side of the arena after making a single choice. On half of the trials, Model and Subject Rats were tested together, with the matchups of Model and Subject Rats varying over trials. On those trials, the Subject Rats were socially influenced by the Model rats to choose a location on the correct (baited) side of the arena, but that social influence was restricted to the first choice of each trial only. This is important because it is only during the first choice that individual experience cannot guide the Subject Rats' choices to the baited side. During subsequent choices, when the outcome of choices made earlier during the trial reveal the locations of the baited pits, there was no difference in choice accuracy of the Subject Rats when they were tested together with the Model Rats in comparison to the control trials in which they were tested alone.

In another experiment using different rats (Bisbing et al., 2015, Experiment 3) the relevance of the social information was increased, relative to the experiments just described. Specifically, the subset of locations baited on each trial was 5 of the 25 pits, randomly chosen. As in the earlier experiments, the baited subset remained constant for Model Rats, but varied unpredictably over trials for the Subject Rats. In addition, the five baited pits were baited with a large supply of pellets that was not depleted when chosen by a rat. Thus, the Model Rats potentially provided information to the Subject Rats about the location of food that was not otherwise available. In fact, the choices made by the Subject Rats were strongly controlled by the choices of the Model Rats

in this experiment. The results of the experiments reported by Bisbing et al. (2015) considered as a whole strongly suggest that social information was used to locate food by the Subject Rats only when personal information (the outcome of the Subject Rats' own choices) did not specify the remaining baited locations. It suggests that social information controls behavior only when it is not redundant with personal information.

1.3. Goals and logic of the present experiment

In the experiments of Bisbing et al. (2015), primary control of spatial choices was either by personal information or by social information. Can both kinds of information jointly or flexibly control spatial choices? The present experiment was designed with a combination of the contingencies in the experiments of Bisbing et al. (2015) to reveal relationships between control by individual experience and social information. Specifically, partial information about the location of food could be acquired via individual experience. However, more complete information about the location of food was available if another rat (the Model Rat) was making choices at the same time.

This experimental design was implemented using sets of baited locations consisting of five pits selected randomly from among the 10 pits on either side of the arena. Half of the Model Rats in the experiment were assigned a set of five baited pits on the east side of the arena and the remaining half were assigned a set of five baited pits on the west side of the arena. As in the earlier experiments, the assigned set remained constant over trials for the Model Rats but Subject Rats were paired with different Model Rats over trials, and therefore had different sets of baited pits over trials (on the east side for half of the trials and on the west side for half of the trials). The Subject Rat and the Model Rat with which it was paired for a particular trial were tested together on half of the trials and separately on the other half of the trials.

From the perspective of the Subject Rats, individual experience can provide partial information about the location of baited pits. Specifically, once the location of one or more baited pits is determined, the baited side of the arena is determined. Also, if pits on one side of the arena are chosen and found not to contain food, it becomes decreasingly likely that baited pits are located on that side of the arena. Although the arena side containing the baited pits can be determined based on the outcome of a Subject Rat's own choices, the specific pits baited within the baited side cannot be so determined. However, the choice behavior of the Model Rat during trials in which rats are tested together provides information about the specific locations of baited pits (assuming the Model Rats learn the assigned locations and selectively choose them).

1.4. Empirical predictions

Control by individual experience (i.e., the outcome of the rat's own choices) would be indicated by the Subject Rats acquiring an ability to choose pits on the baited side of the arena after making a choice or two, even when they are tested alone. However, assuming there are no unintended perceptual cues to the location of the food, they should show no ability to choose baited pits over unbaited pits on the baited side of the arena. If their choices can also be controlled by social information, the Subject Rats are predicted to also acquire a tendency to choose the baited locations that the Model Rat chooses over the unbaited locations on the baited side of the arena.

The earlier findings of strong control by personal information with very limited control by social information (Bisbing et al., 2015, Experiments 1 and 2) or strong control by social information when there is no personal information available (Bisbing et al., 2015, Experiment 3) suggest that spatial choices may be controlled in

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