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Blocking and unblocking in a navigation task

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Rodrigo, Chamizo, McLaren, & Mackintosh (1997) demonstrated the blocking effect in a navigational task using a swimming pool: rats initially trained to use three landmarks (ABC) to find an invisible platform learned less about a fourth landmark (X) added later than did rats trained from the outset with these four landmarks (ABCX). The aim of the experiment reported here was to demonstrate unblocking using a similar procedure as in the previous work. Three groups of rats were initially trained to find an invisible platfom in the presence of three landmarks: ABC for the Blocking and Unblocking groups and LMN for the Control group. Then, all animals were trained to find the platform in the presence of four landmarks, ABCX. In this second training, unlike animals in the Blocking group to which only a new landmark (X) was added in comparison to the first training, the animals in the Unblocking group also had a change in the platform position. In the Control group, both the four landmarks and the platform position were totally new at the beginning of this second training. As in Rodrigo et al. (1997) a blocking effect was found: rats in the Blocking group learned less with respect to the added landmark (X) than did animals in the Control group. However, rats in the Unblocking group learned about the added landmark (X) as well as did animals in the Control group. The results are interpreted as an unblocking effect due to a change in the platform position between the two phases of training, similarly to what is normal in classical conditioning experiments, in which a change in the conditions of reinforcement between the two training phases of a blocking design produce an attenuation or elimination of this effect. These results are explained within an error-correcting connectionist account of spatial navigation (McLaren, 2002).

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Several earlier studies (Biegler & Morris, 1999; Chamizo, Sterio, & Mackintosh, 1985; Cheng & Spetch, 2001; Hamilton & Sutherland, 1999; Rodrigo, Chamizo, McLaren, & Mackintosh, 1997; Roberts & Pearce, 1999) have demonstrated blocking in spatial learning, a finding which is consistent with associative theory but not with O'Keefe & Nadel (1978). Specifically, O'Keefe and Nadel claimed that true spatial learning or "locale" learning according to them (i.e., the ability to locate a hidden goal by reference to its distance and direction from a number of distal landmarks), which implies the possession of a map, occurs non-associatively, in an all-or-none manner, and that animals constantly update their cognitive map of their environment. How could that be tested? Morris (1981) suggested that one way to test for this would be to see whether specific basic pavlovian phenomena, like blocking (Kamin, 1969) and latent inhibition (Lubow, 1989), which are routinely observed in experiments of simple conditioning, are also observed when learning a cognitive map. If this is the case, that would imply that the processes underlying both types of learning are the same (for recent reviews of this literature see Chamizo 2003; Rodrigo & Prados, 2003; and a whole monographic issue of the journal *Psicológica* -see Mackintosh & Chamizo, 2002).

Blocking is observed when prior establishment of one element of a compound cue as a signal for reinforcement reduces or blocks the amount learned about a second (Kamin, 1969). According to Kamin, if the US is signaled by a previously conditioned stimulus, it will not be surprising and therefore will not condition the added stimulus (i.e., an unsurprising US will not stimulate the "mental effort" which is needed for the formation of an association). Thus, surprise of the US is necessary for learning to occur. Is blocking among landmarks possible? To answer this question was the aim of the study by Rodrigo et al. (1997). In the experiments of this study, rats had to find a hidden platform by means of a number of landmarks which were inside a circular curtain that surrounded the pool (i.e., by "locale" learning according to O'Keefe & Nadel, 1978). In Experiment 1 (specifically, in Experiment 1C), in order to equate as much as possible the experience of all rats with the different landmarks, a procedure (Whishaw, 1991) that permitted good spatial learning after placement trials (i.e., rats were simply allowed to observe the relevant landmarks), followed by a few escape trials before testing, was developed. With this new procedure, three landmarks were needed for rats to find the hidden platform. Then, Experiments 2 and 3 were designed to see whether rats initially trained to use three landmarks to find the platform, learned less about a fourth landmark when it was added to the previous set of landmarks than did rats trained from the outset with all four landmarks. In the two experiments a clear blocking effect was found: rats that had already learned to locate the hidden platform by reference to three landmarks, A, B, and C, learned less about a fourth landmark, X, when it was added than did a control group trained either with all four landmarks from the outset (Experiment 2), or with a different set of landmarks in the first phase (Experiment 3). This result is that expected by any standard associative learning theory.

But sometimes blocking does not occur. For example, a change in the conditions of reinforcement between the first and the second phases of an experiment can produce an attenuation or even a total elimination of this effect (Dickinson, Hall, & Mackintosh, 1976; Kamin, 1969; Mackintosh, Bygrave, & Picton, 1977; Weaver y Gordon, 1988). This is called unblocking. The aim of the experiment reported here was to look for unblocking, another parallel with the results of conditioning experiments, by means of a new manipulation (specifically, a surprising new position of the hidden platform during the second phase of the experiment). A similar procedure as in the study by Rodrigo et al. (1997) was used, thus complementing this study (and for overshadowing among landmarks, also with the same procedure, see Sánchez-Moreno, Rodrigo, Chamizo, & Mackintosh, 1999). Three groups of rats were initially trained to find an invisible platfom in the presence of three landmarks: A, B, and C for Blocking and Unblocking groups and L, M, and N for the Control group. Then, all animals were trained to find the platform in the presence of four landmarks, A, B, C, and X. In this second training, unlike animals in the Blocking group for which only a new landmark (X) was added in comparison to the first training, the animals in the Unblocking group had also a change in the platform position. In group Control, both the four landmarks and the platform position were totally new at the beginning of this second training. It was expected a blocking effect between groups Blocking and Control, and an elimination of this effect (i.e., unblocking) between groups Unblocking and Control, due to the change in the position of the platform between the two phases of the experiment in group Unblocking. A significance level of $p<.05$ was adopted for the statistical tests reported in this experiment.

METHOD

Subjects. The animals used were 60 Long Evans rats, 28 males and 32 females, approximately 4 months old at the beginning of the experiment and experimentally naive. They were maintained on ab-lib food and water, in a colony room maintained on a 12:12-h light-dark cycle, and were tested within the first 9 h of the light cycle. Two females were eliminated from the experiment because they did not find the platform on trials 4 and 5 of pretraining, leaving a total of 58 animals. The rats were divided into three groups, Unblocking, Blocking, and Control, with 19, 20, and 19 animals, respectively, matched, as far as possible, for sex and for latency to find the platform on pretraining trials. The experiment was run in two identical replications, with 34 rats (16 males and 18 females) in the first replication, and 24 (12 males and 12 females) in the second.

Apparatus. The apparatus was a circular swimming pool, made of plastic and fiberglass, modelled after that used by Morris (1981), and described in detail in Rodrigo et al. (1997). It measured 1.58 m in diameter and 0.65 m deep, and was filled to a depth of 0.49 m with water rendered opaque by the addition of 1 cl/l of latex. The water temperature was maintained at 22 ± 1° C. The pool was situated in the middle of a large room, mounted on a wooden platform 0.43 m above the floor, and it was surrounded by black curtains reaching from ceiling to the base of the pool and forming a circular enclosure 2.40 m in diameter. Inside the black enclosure, round the curtains, and hanging from a black false ceiling, a number of objects were placed. These objects or landmarks defined the location of the platform. In order to ensure that the rats used these landmarks, rather than any inadvertently remaining static room cues, to locate the platform, the landmarks and platform were semi-randomly rotated with respect to the room (90°,180°, 270° or 360°), with the restriction that all parts of the room were equated each day. A closed-circuit video camera with a wide angle lens was mounted 1.75 m above the center of the pool inside the false ceiling, and its picture was relayed to recording equipment in an adjacent room. A circular platform, 0.11 m in diameter and made of transparent Perspex was mounted on a rod and base, and could be placed in one quadrant of the pool, 0.38 m from the side, with its top 1 cm below the surface of the water.

The landmarks used were as follows: A, a 40-W light placed inside a white plastic inverted cone 11 cm high and 13 cm diameter at the base; B, a 30-cm diameter plastic beach ball with alternate blue, white, yellow, white, orange and white vertical segments; C, an intermittent 1-W light flashing on and off at a frequency of 1 to 1.2 Hz; L, a white cardboard cube, 20 cm on edge, with a black circle 9.5-cm in diameter painted on each side; M, a string of colored Christmas tree lights, consisting of eight 2.75-W bulb flashing on and off 15 times per minute; N, a white cardboard cone 16 cm in diameter and 59 cm in height, with 1-cm thick black horizontal stripes spaced 3.5 cm apart; X, a green plastic plant approximately 35 cm in diameter and 30 cm high. The landmarks were suspended from the false ceiling, 35 cm above the surface of the water and with the mid-line directly above the wall of the pool. The entire false ceiling, with these landmarks suspended, could be rotated from trial to trial, and the platform always rotated with them.

Procedure. There were three phases in the present experiment (Pretraining, Training with 3 landmarks and subsequent Test, and Training with 4 landmarks and subsequent Tests).

Pretraining. Pretraining consisted of placing the rat into the pool, without landmarks but with the platform present. The rat was given 180 sec to find the platform, where it was allowed to stay for 30 sec. If a rat had not found the platform within 180 sec, it was picked up, placed on it, and left there for 30 sec. Rats were given five such pretraining trials, at a rate of one per day. Te platform was moved from one trial to the next, and the rat was placed in the pool in a different location on each trial (at one of the four points, A, B, C, X, in Figure 1 -column: Acquisition 2), equally often as far as possible on the same or opposite side of the pool from the platform and with the platform to the right and to the left of where the rat was placed.

Training with 3 landmarks and subsequent Test. There were three types of trial in this phase: placement, escape, and test trials. Placement trials involved placing the rat directly onto the platform and leaving it there for 60 sec. Three landmarks were always present. Rats in the Unblocking and Blocking group were trained in the presence of A, B, and C; those in the Control group, in the presence of L, M, and N. There were eight placement trials per day during six days (a total of 48 trials), with an average ITI of 12-15 min. The platform position was between A and B for the Unblocking group, between B and C for the Blocking group, and between L and M for the Control group (see Figure 1). The landmarks and platform were rotated in a semi-random way between each trial. At the end of the placement trials, all rats received two days with escape trials. The procedure for the escape trials was exactly the same as for pretraining except that the landmarks (which were the same for each group as in the placement trials) and the platform were always present. There were four escape trials per day , with an average ITI of 10-20 min. The landmarks and platform were rotated in a semi-random way between each trial. On each block of four trials the rat was placed in the pool once at A, once at B, once at C, and once at X. At the end of the second day with escape trials all rats received one test trial, each group with the same three landmarks as in the placement and escape trials (A, B, and C for the Unblocking and Blocking groups, and L, M, and N for the Control group). A test trial consisted of placing the rat in the pool, with landmarks present but without the platform, and leaving it there for 120 sec. For purposes of recording the rat's behaviour, the surface of the pool was divided into four quadrants: where the platform should have been, right to it, left to it and opposite to it, and the amount of time that the rat spent in the platform quadrant was recorded. The position of the platform quadrant varied with the different groups and phases of the experiment (see Figure 1).

Training with 4 landmarks and subsequent Tests (ACX Set 1, ACX Set 2, ABC). During training, the general procedure for this phase was exactly the same as for the previous phase except that four landmarks, A, B, C, and X, were now present for all rats and that the platform was always between B and C (see Figure 1). There were eight placement trials per day during four days (a total of 32 trials), with an average ITI of 12-15 min. Following this, rats received four escape trials with all four landmarks and, on each of the following 2 days, again four escape trials with the four landmarks which were followed by one test trial in the presence of A, C, and X. Since no statistical diference was found between the Blocking and Control groups in these test trials (Set 1 of ACX), the same set of tests (now Set 2 of ACX) was repeated -i.e., two days, each of them with four escape trials which were followed by one test trial with A, C and X. Finally, rats were given one day with 4 escape trials followed by a test trial with A, B, and C.

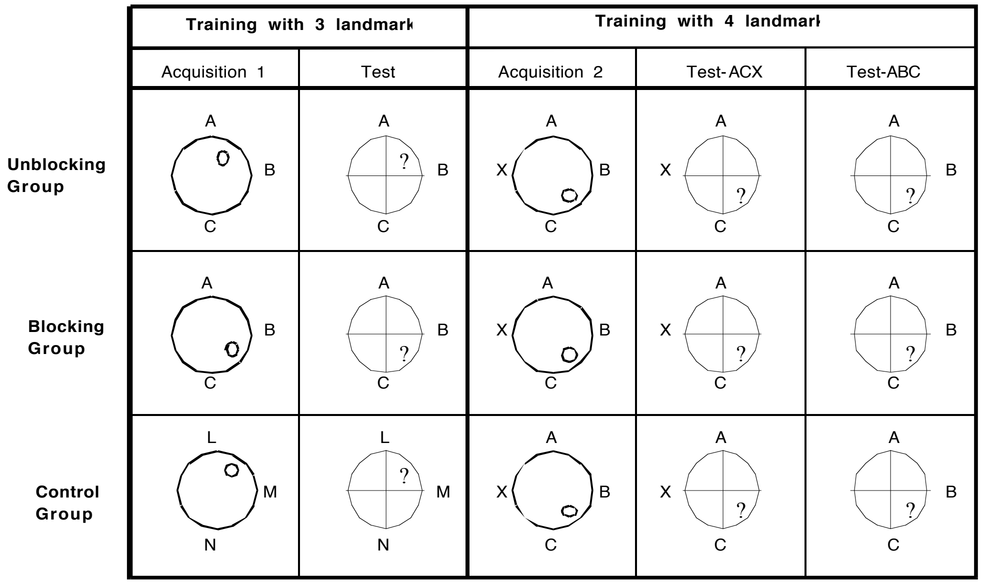

Figure 1. A schematic representation of the pool and the landmarks position, as well as the platform, in each experimental phase for the Unblocking, Blocking, and Control groups.

RESULTS

Training with 3 landmarks and subsequent Test. On the first block of four escape trials after the end of placement training with 3 landmarks, the mean latency to find the platform was 26.89 sec in the Unblocking group, 28.87 sec in the Blocking group, and 28.76 sec in the Control group. By block 2, these escape latencies had declined to 19.07, 21.88, and 16.70 sec, respectively. An analysis of variance (ANOVA) revealed a significant effect of blocks, $F(1,55) = 12.98$, but no diference between groups, and no interaction between groups and blocks (Fs <0.5). An analysis of variance of the test trial revealed a significant difference between groups, $F(2,55) = 6.09$. Subsequent *t* tests comparisons showed that the Control group spent more time in the platform quadrant than the Blocking group. Additional *t* tests were used to compare rats' performance in the three groups with chance (i.e., 30 sec searching in the quadrant where the platform should have been) in order to evaluate whether the test results reflected significant spatial learning. The results showed that the performance of the three groups was significantly better than chance, thus reflecting spatial learning; $t(18)= 7.26$ for the Unblocking group; $t(19)= 3.7$ for the Blocking group; and $t(18)= 9.94$ for the Control group.

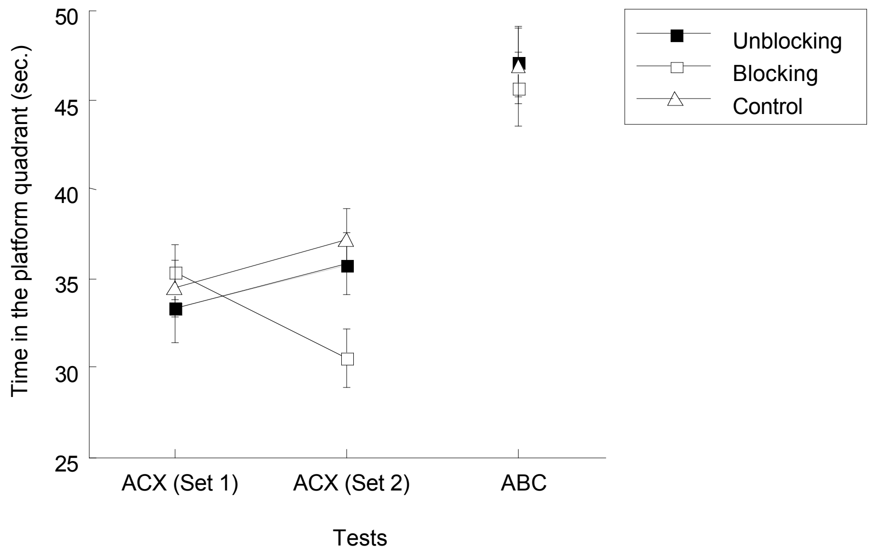

Figure 2. Meantime spent in the platform quadrant by the three groups on test trials with A,C, and X, both in Set 1 and in Set 2 (with the two days on each set averaged), and in the final test trial with A,B, and C. Error bars denote estandard error of the mean.

Training with 4 landmarks and subsequent Tests. On the first block of four escape trials after the end of placement training with 4 landmarks, the mean latency to find the platform was 42.69 sec in the Unblocking group, 26.08 sec in the Blocking group, and 34.10 sec in the Control. By block 6, immediately before the final test trial in the presence of A, B, and C, these latencies had declined to 12.73, 14.14, and 14.85 sec, respectively. An analysis of variance (ANOVA) revealed a significant effect of groups, $F(2,55) = 3.34$, and blocks, $F(5,275) = 22.05$. The interaction between groups and blocks was not significant ($F< 1.5$). Subsequent *t* test comparisons showed that Unblocking animals took more time to find the platform in these escape trials than Blocking rats.

On test trials with A, C, and X an analysis of variance (ANOVA) with Groups, Sets and Days as factors revealed a significant interaction of Groups by Sets, $\underline{F}(2,55) = 5.94$. No other main effect or interaction was significant (*F*s< 1.0). An analysis of the simple effects of this interaction, groups by sets, showed that the groups differed on Set 2 only, $\underline{F}(2,55)= 4.28$. Additional *t* test on Set 1, considering the three groups together, to compare rats' performance (day 1 and day 2 combined) with chance (i.e., 30 sec.) in order to evaluate whether the test results reflected significant spatial learning revealed that the performance was significantly better than chance, $t(57)= 14.15$. Subsequent *t* test comparisons of test trials with A, C, and X on Set 2, showed that two of the groups, Group Unblocking and Group Control, which did not differ between them, performed significantly better than the Blocking group. Additional *t* tests on Set 2 to compare rats' performance with chance (day 1 and day 2 of each group combined) revealed that while the performance of the Unblocking and Control groups was significantly better than chance, $t(18)$= 3.28 for the Unblocking group, and $t(18)$= 4.24 for the Control group, thus reflecting spatial learning, the performance of the Blocking group did not differ from chance ($t < 0.4$). Finally, all three groups performed at a similar, high level of accuracy on the final test to A, B, and C. No statistical difference betwen the groups was found ($F < 0.5$). Additional *t* test, considering the three groups together, to compare rats' performance (day 1 and day 2 combined) with chance (i.e., 30 sec.) revealed that the performance was significantly better than chance, thus reflecting spatial learning, $t(57)$= 14.15. Figure 2 shows the mean time in the platform quadrant of the three groups on test trials with A, C, and X on Set 1 and on Set 2 (averaging the two days in each set), and in the final test trial, with A, B, and C.

DISCUSSION

Considering the test trials with A, C, and X (Set 2), as well as the final test trial, with A, B, and C, the present experiment replicates the finding that previously established landmarks block learning about a new subsequently introduced landmark and, most importantly, that a change in the position of the platform between the two phases of the experiment can eliminate this effect. Perhaps the additional escape trials before the two test trials with A, C, and X on Set 2 could be responsible for the different results of Set 2 in comparison with those obtained on Set 1. Similarly, Rodrigo et al. (1997) and Sánchez-Moreno et al. (1999), using the same procedure of this study, found that their blocking and overshadowing effects, respectively, were not necessarily evident on a first test trial. In fact, Sánchez-Moreno et al. (1999) reported about a preliminary experiment where the effect did not emerge until a second set of test trials was given. The explanation was that this may have been a consequence of the use of such a placement procedure for training, and therefore that it was possible that rats needed the experience of a number of escape training trials in order to reveal a significant effect on test. There is no reason to think that this explanation cannot be applied to our new results. As in the Rodrigo et al. (1997, Experiment 3) study, a clear blocking effect was found in the experiment presented here on test trials with A, C, and X (Set 2) and the final test with A, B, and C: Rats in Group Blocking, that had already learned to locate the hidden platform in the pool by reference to three landmarks, A, B, and C, learned less about a fourth landmark, X, when it was added than did the Control group; this group had initial training with a different set of landmarks, L, M, and N, and then a second training with A, B, C, and X. These two groups, Blocking and Control, had the same opportunity to learn about X during the second training phase of the experiment, with the four landmarks. In fact this seems to have been the case when observing the absence of differencies in the latencies on the four escape trials on the last test day -with A, B, and C (14.14 in Group Blocking, and 14.85 in Group Control), which supports this claim. But most important in the present experiment is the demonstration of unblocking in the spatial domain: Rats in Group Unblocking, that had already learned to locate the hidden platform in the pool by reference to three landmarks, A, B, and C, and for which a new platform position was introduced in the second phase of the experiment in addition to the added landmark, X, showed an absence of the blocking effect. These rats, the Unblocking group, learned about landmark X as well as did animals from the Control group. These results show unblocking of learning about a new landmark when a change in the location of reinforcement was introduced between the first and the second phases of the experiment -a result expected by any standard associative learning theory.

Numerous studies using more standard stimuli than those in the present experiment have already shown that the degree of blocking can depend both on CS and US variations. For example, the amount of blocking is related to the salience or intensity of the two elements or events, the pretrained and the added one: a more pronounced blocking effect is observed when the pretrained element is more intense than the added element and viceversa (Feldman, 1975; Hall, Mackintosh, Goodall, & Dal Martello, 1977; Kamin, 1968). The amount of blocking is also directly related to the amount of previous conditioning: the greater the amount of conditioning to the pretrained element, the bigger the blocking effect observed and viceversa. For example, Kamin (1969) demonstrated a stronger conditioning of the added element, and therefore a reduced blocking, if in phase one the pretrained element had not reached the asymptote level of conditioning. This result has also been found in the spatial domain. Roberts and Pearce (1999) have demonstrated a stronger conditioning of the added cues (room cues), and therefore a reduced blocking, if in phase one the pretrained cue (a beacon) had not reached the asymptote level of conditioning: When rats were able to escape from a pool by swimming to a beacon that had been constantly located above the platform, they failed to learn about the significance of additional room cues that were subsequently introduced; and reducing the amount of training, attenuated the blocking effect. And in a different experiment Roberts and Pearce (1999) found that changing the physical features of a beacon that was presented with room cues between the two phases of conditioning also attenuated the blocking effect. As Roberts and Pearce (1999) already claimed, these results are those predicted by the Rescorla and Wagner model (1972).

Most frequently the degree of blocking depends on variations of the second event of a trial, the US or outcome (but see Bakal, Johnson, & Rescorla, 1974, Ganesan & Pearce, 1988, and Williams, 1994 for three examples of blocking in spite of variations of the second event of a trial provided that the general, affective properties of the US remained unchanged). For example Kamin (1969) found an attenuation or elimination of the blocking effect when the US intensity between the two phases of conditioning was altered. An attenuation of blocking has also been found when the pretrained element was followed by one shock and then the compound element was followed by two shocks 5 sec. apart one from the other (Kamin, 1969); when the pretrained element was followed by two shocks 4 sec. apart one from the other and then the compound element was followed by two shocks 8 sec. apart one from the other (Dickinson, Hall, & Mackintosh, 1976); when the pretrained element was followed by two shocks and then the compound element was followed by one shock only (Dickinson, Hall, & Mackintosh 1976; Dickinson & Mackintosh 1979; Mackintosh & Turner, 1971; Mackintosh, Bygrave & Picton, 1977); when the pretrained element was followed by one shock and then the compound element predicted no shock (Kamin, 1969); and when a change of context was introduced between the two phases (Weaver y Gordon, 1988).

Unblocking results following an increase in the magnitude of the US or outcome of the trials on the second phase of a blocking design are consistent with the idea of surprise in the Rescorla and Wagner model (1972); the reason being that the new magnitude of the US augments the model discrepancy, $\lambda - \Sigma Vs$, on the second training phase thus allowing learning between the added stimulus and the new surprising US or outcome. But results like the surprising omission of an expected shock or post-trial shock (Kamin, 1969; Dickinson, Hall, & Mackintosh 1976; Mackintosh, Bygrave & Picton, 1977), cannot be explained by the Rescorla and Wagner (1972) model. As neither can be the manipulation used in the present experiment (i.e., moving the position of the platform between the two training phases for the animals in the Unblocking group), because this manipulation can hardly be understood as a change in the magnitude of the outcome of the trials on the second training phase; and nevertheless, unblocking was found. Thus, this result is also inconsistent with the idea of surprise in the Rescorla and Wagner (1972) model. The implication is that some aspects of the role of surprise in learning (for example see Mackintosh, 1975b) could better be explained by other models, such as attentional ones (for example, Mackintosh, 1975a; Pearce and Hall, 1980).

Could a model of spatial navigation based on associative mechanisms explain these results? As Rodrigo et al. (1997) have already suggested, it is clear that animals' ability to locate themselves and their goals in a spatial environment depends on their use of a complex configuration of most, if not all, available spatial landmarks. Although for a theory of spatial navigation which is based on general principles of associative learning, it may seem a simple matter to predict a blocking effect, this reliance on a number of redundant landmarks is a feature of spatial learning that, initially, makes things difficult to understand. However, McLaren (2002) has produced an error-correcting connectionist model of spatial navigation that combines the ability to use cue or landmark combinations in a redundant fashion (O'Keefe and Conway, 1978) at the same time as allowing for the spatial equivalent of blocking (Rodrigo et al., 1997). According to McLaren's (2002) model, blocking is explained because the learning required to incorporate X into a new configuration with A, B, and C to define the location of the platform occur more slowly in pretrained animals than in control animals; the reason being that the effect of such pretraining with A, B, and C should be to reduce the mismatch between them and the goal position. Most importantly, this model can also explain the results of the present experiment, namely unblocking. According to this model, the error score for those subjects previously trained with three landmarks, A, B and C, would be bigger when subsequently trained in the presence of A, B, C, and X if a change in the platform position was also introduced; the consequence being that learning about X when it is added as a landmark to the previous set of landmarks should be facilitated.

To conclude, in agreement with McLaren (2002), we believe that a relatively sophisticated guidance system can, in principle, explain at least a number of basic phenomena, like blocking and unblocking, with respect to spatial navigation, and that more research is certainly needed to develop such possibilities further.

RESUMEN

Bloqueo y desbloqueo en una tarea de navegación. Rodrigo, Chamizo, McLaren y Mackintosh (1997) demostraron el efecto de bloqueo en una tarea de navegación usando una piscina circular: unas ratas a las que inicialmente se las entrenó a usar tres puntos de referencia (ABC) para encontrar una plataforma invisible aprendieron menos con respecto a un cuarto punto de referencia (X) que se añadió posteriormente, de lo que lo hicieron otras ratas entrenadas desde el principio con estos cuatro puntos de referencia (ABCX). El propósito del experimento que se presenta aquí era el de demostrar desbloqueo usando un procedimiento similar al del trabajo previo. Inicialmente se entrenó a tres grupos de ratas a encontrar una plataforma invisible en presencia de tres puntos de referencia: ABC para los grupos Bloqueo y Desbloqueo, y LMN para el grupo de Control. Posteriormente, se entrenó a todos los animales a encontrar la plataforma en presencia de cuatro puntos de referencia, ABCX. En este segundo entrenamiento, a diferencia de los animales del grupo Bloqueo a los que sólo se les añadió un nuevo punto de referencia (X) con respecto al primer entrenamiento, los animales del grupo Desbloqueo también tuvieron un cambio en la posición de la plataforma. En el grupo de Control, tanto los cuatro puntos de referencia como la posición de plataforma fueron totalmente novedosos al inicio de este segundo entrenamiento. Como en Rodrigo y cols. (1997), se encontró un efecto de bloqueo: las ratas del grupo Bloqueo aprendieron menos con respecto al punto de referencia añadido (X) de lo que lo hicieron los animales del grupo de Control. Sin embargo, las ratas del grupo Desbloqueo aprendieron sobre el punto de referencia añadido (X) tanto como los animales del grupo de Control. Los resultados se interpretan como un efecto de desbloqueo debido a un cambio en la posición de la plataforma entre las dos fases de entrenamiento, de manera similar a lo que ocurre en experimentos de condicionamiento clásico, en los que un cambio en las condiciones del reforzamiento entre las dos fases de entrenamiento de un diseño de bloqueo produce una atenuación o eliminación de este efecto. Estos resultados se explican en el marco de un modelo conexionista de corrección de error de la navegación espacial (Mclaren, 2002).

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