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Effects of Perceived Audiences on Discrimination Learning in Pigeons (*Columbia Livia*)

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Abstract

The social facilitation effect is a phenomenon frequently discussed in the subfield of social psychology. Some studies have examined the social facilitation or inhibition effects in nonhuman animals, though few have examined the effect of perceived audiences on their cognitive functioning. In order to study this effect, three different video stimuli were presented to one subject while solving a memorization discrimination task. It was hypothesized that the pigeon would learn a task at different rates based on the type of perceived audience presented. No significant results were found due to the fact that the subject was unable to learn the task to criterion.

Effects of Perceived Audiences on Discrimination Learning in Pigeons (*Columbia Livia*)

The idea that there exists some differential expression of behavior due to the presence of an audience has been of interest to psychologists since the late nineteenth century when Triplett (1898) studied the performance of racing cyclists. Social psychologists have continued studying this audience effect (also known as the social facilitation effect) for more than a century, trying to determine why this difference in performance exists. Several competing theories have been proposed, including Zajonc's (1965) drive theory, Henchy and Glass's (1968) evaluation apprehension hypothesis, and Sanders, Baron, & Moore's (1978) distraction-conflict theory. The drive theory states that the presence of an audience, regardless of an evaluative or judgemental aspect, increases arousal in the subject, which leads to improved performance on well-known or easy tasks and worsened performance on difficult or unfamiliar tasks (Platania & Morgan, 2001; Rajecki, Ickes, Corcoran, & Lenerz, 1977; Shaver & Liebling, 1976; Zajonc, 1965). On the other hand, the evaluation-apprehension hypothesis claims that there must be some element of evaluation present in the audience in order for some differential performance to occur, and that the mere presence of an audience is not enough to elicit this response (Henchy & Glass, 1968). To further complicate things, the distraction-conflict theory claims that the presence of the audience is merely a distraction to the subject and results in a lack of concentration on the task at hand, which may result in differential performance (Sanders et al., 1978). Each of these competing theories attempts to best explain the seemingly contradictory results when studying the audience effect. There has yet to be a conclusive understanding of this phenomenon, other than the fact that this difference exists.

In recent decades, psychologists have begun using animal models in an attempt to further explore how pervasive the audience effect is in nature. It seems to be agreed upon that the social facilitation effect is not unique to humans and that it does, in fact, occur in a variety of nonhuman animal species including cockroaches (Planas-Sitjà & Deneubourg, 2018; Zajonc, Heingartner, & Herman, 1969), pigs (Boumans, de Boer, Hofstede, & Bokkers, 2018), rats (Gipson et al., 2011), frogs (Höbel, 2017), elephants (Leighty, Soltis, Leong, & Savage, 2008), horses (McVey, Wilkinson, & Mills, 2018; Rørvang, Christensen, Ladewig, & McLean, 2018), crows (Miller, Schiesti, Whiten, Schwab, & Bugnyar, 2014), kangaroos (Pays et al., 2009), dogs (Vogel, Scott, & Vesta-Marston, 1950), fish (Ward, 2012; Zion, Barki, Grinshpon, Rosenfeld, & Karplus, 2007), and primates (Dindo, Whiten, & De Waal, 2009; Reynaud, Guedj, Hadj-Bourziane, Meunier, & Monfardini, 2015). Many of these studies define the increase or decrease in behavior as some innate behavior in their chosen animal model (i.e., food intake, reproductive rituals, calls, etc.), while relatively few have examined the effect of audiences on strictly cognitive tasks. Notable exceptions to this generalization include studies conducted by Hamrick et al. (1971), McVey et al. (2018), Reynaud et al. (2015), and Zajonc et al. (1969). Further, the aforementioned studies have chosen to use live audiences as the independent variable, which presents its own unique set of complications and limitations in generalizability. When live audiences are used, it is difficult to control for their behavior, especially in a field study conducted without laboratorial control. For this reason, it may be useful to examine the effects of perceived (but non-physical) audiences on the behavior of human and nonhuman animals. Further, this use of perceived audiences may have implications on various facets of

human behavior in an increasingly globalized society that remain markedly different when compared to live audiences.

In human research, there have been some studies examining the effect of virtual audiences on behaviors such as gambling (Cole, Barrett, & Griffiths, 2011; Rockloff & Dyer, 2007; Rockloff, Greer, & Fay, 2011) and visual search tasks (Liu & Yu, 2017). These results seem to suggest that the audience effect is still present even when perceived audiences are used in place of physical ones. This finding appears to be further confirmed by Zajonc et al.'s (1969) study involving cockroaches running a maze using dead cockroaches as a perceived audience. The idea of a perceived audience is not in conflict with prior proposed explanations for the audience effect, as it is possible that the mere presence of the perception of an audience (as opposed to a live one) may be enough to elicit a difference in performance in line with Zajonc's drive theory (1965); if the perceived (and non-physical) audience is presented in an evaluative context, it may provide support for Henchy and Glass's (1968) evaluation apprehension hypothesis; finally, the perception of an audience may be enough to distract the subject from the task at hand, as predicted by Sanders et al. (1978).

One concern raised in the process of this study was whether or not pigeons can perceive the video accurately as another pigeon. Strictly in terms of psychophysics, a critical component to being able to recognize a moving video as an object is being able to see the video as more than just a series of still photographs. If the refresh rate of the screen is less than the critical flicker fusion rate (CFF) of an organism, the image will appear to flicker with periods of darkness — that is, the image will not appear to be in smooth, constant motion. Most modern screens are designed such that humans can view them in a steady constant image; however, not all organisms

have the same CFF cutoff. Pigeons have a CFF threshold of about 58 Hz when the monitor brightness is held constant at 70 cd/m², as the CFF threshold is dependent upon the brightness of the monitor (Watanabe & Furuya, 1997); most modern computer monitors have a refresh rate between 60-140 Hz. As such, this may present issues if the refresh rate on the monitor is too high, or if the monitor is too bright. In order to control for this, the refresh rate should be as low as possible (around 60 Hz) and the brightness of the monitor should be relatively low. In addition, pigeons have been shown to accurately discriminate between pigeons and rats (Watanabe & Troje, 2006). This may not be enough to elicit a social response, as it cannot necessarily be concluded that the subject recognizes an on-screen pigeon as a conspecific; however, this uncertainty lies at the heart of this experiment. If the pigeon could not recognize the social condition video as a conspecific, it would be expected that there would be no significant difference in the rates of memorization between at least the neutral and social video conditions.

The purpose of the present study was to observe the effect of perceived visual audiences in pigeons solving a memorization discrimination task. For as much as they are used in other cognitive/behavioral studies, pigeons are relatively understudied in literature examining the social facilitation effect in nonhuman animals; further, most studies using animal subjects to explore social facilitation do so in terms of natural or innate behaviors, rather than strictly in terms of cognitive abilities. Additionally, much of the research in humans and nonhuman animals involves live audiences rather than perceived audiences, which in and of itself presents a unique set of implications that may differ from those presented with a live audience.

It was predicted that, in the current study, there will be some difference in the rates of memorization in the pigeon due to the video presented, which is consistent with the social facilitation/inhibition effect. It is possible that, due to the fact that pigeons are relatively nonsocial animals (that is, they tend not to have as strong a social structure compared to other species of birds), there may not be as strong a social facilitation or inhibition effect as there may if a different species of bird were used; however, given that a difference in performance was observed in cockroaches, like in Zajonc et al.'s study (1969), there should be at least some marked difference in rates of memorization in pigeons.

Methods

Subject

For this study, one experimentally naive pigeon was used for a 50-session within-subject study with 30 trials per session. Ideally, a larger sample size would have been used; however, due to time and personnel constraints, only one pigeon was available to train to the task. The pigeon was housed alongside three other pigeons that resided in a room with a 12 hours light/12 hours dark light cycle. All pigeons were kept at 75-85% free feeding weight for the duration of the study and were fed daily or every other day. All pigeons were fed grain-mix outside of testing. The same grain-mix was available as reinforcement for the pigeon in the current study, but the delivered reinforcement was not a significant contributor to the pigeon's diet. The pigeon was tested three times a week, with testing lasting between 30-60 minutes per session.

Apparatus

A plywood operant chamber measuring approximately 24 inches tall x 12 inches wide x 12 inches deep was used for testing. One face was left partially open and faced a 27 inch

computer monitor placed 6 inches away from the opening of the chamber. The experimenter sat one foot away on the left side of the open face of the chamber. When the pigeon was not actively testing, a cloth was drawn over the open face of the chamber to prevent distraction or biasing before the start of a trial.

Procedure

Thirty visual stimuli were presented once each session. Each stimulus corresponded to one of three videos: a social condition which consisted of a prerecorded video of a pigeon, a neutral condition which consisted of a prerecorded video of a white lamb puppet of similar size as a pigeon, and a no-video condition in which the monitor was turned off. Each of the thirty stimuli also corresponded to one of two discriminative stimuli: horizontal stripes or vertical stripes. All stimulus cards measured 2 inches tall x 3 inches wide and were laminated. They were presented manually using wooden apparatuses such that cards were spaced approximately 0.5 inches apart. The pigeon should memorize the orientation of stripes that resulted in reinforcement for each visual stimulus.

At the beginning of each trial, the video condition and the visual stimulus were presented simultaneously. Once the pigeon pecked at the visual stimulus the required number of times, a new set of cards was presented, consisting of the same visual stimulus in the middle, a card with horizontal stripes on either the left or the right, and a card with vertical stripes on the other side. The side presentation of the discriminative stimuli was randomized and counterbalanced each session, and the order in which visual stimuli were presented was randomized as well. Choices were differentially reinforced, such that correct choices resulted in reinforcement of three seconds of free access to a hopper filled with grain mix and incorrect choices resulted in no

reinforcement and a time-out of about five to ten seconds. Intertrial intervals were kept as short as physically possible and typically lasted approximately 30-45 seconds, in which the next trial was set up.

Over the course of the study, several corrections were implemented to try and correct the pigeon's behavior such that it would eventually memorize the stimuli instead of guessing. After approximately ten sessions, it became clear that the pigeon had developed a left-side bias (that is, it was consistently choosing the card on the left of the visual stimulus regardless of the orientation of the stripes). In order to correct for this, a trial was not considered "complete" until the pigeon had picked the correct discriminative stimulus. If it chose incorrectly when first presented with the visual and discriminative stimuli, the trial would restart until the pigeon chose the correct discriminative stimulus. For each time that it chose incorrectly, a five second timeout occurred between repeated trials and it was not reinforced until it chose correctly.

This helped to correct the left-side bias; however, the pigeon's accuracy remained at about chance. As such, the number of pecks required to move on from the visual stimulus to the visual and discriminative stimuli was increased from five to ten and a five-second delay between the time the visual stimulus was removed and the presentation of the visual and discriminative stimuli was implemented in around session 40. This was done in an attempt to coerce the pigeon to engage more with the visual stimuli and to make incorrect choices more costly, as it had to work harder and wait longer in order to get reinforcement. This did not increase accuracy above chance, so the number of pecks to the visual stimulus card was increased to fifteen, and again to twenty over the course of about five sessions.

Results

A one-way analysis of variance was run on the current data to analyze differences among the three video conditions on proportion of accuracy recall. There was not a significant difference of recall due to the neutral ($M = 0.4844$, $SD = 0.05$), social ($M = 0.4933$, $SD = 0.05$), or no video ($M = 0.496$, $SD = 0.05$) conditions; $F(2,132) = 0.074$, $p = 0.929$.

It appears that the probability of picking the correct choice was not significantly above chance (Figure 1). These results are compiled over all 50 sessions; Figure 2 shows the proportion of correct choices by video condition over the last ten sessions. Both charts indicate that learning was not significantly above chance (0.5), indicating that the pigeon likely did not learn the task and was simply guessing rather than memorizing the task.

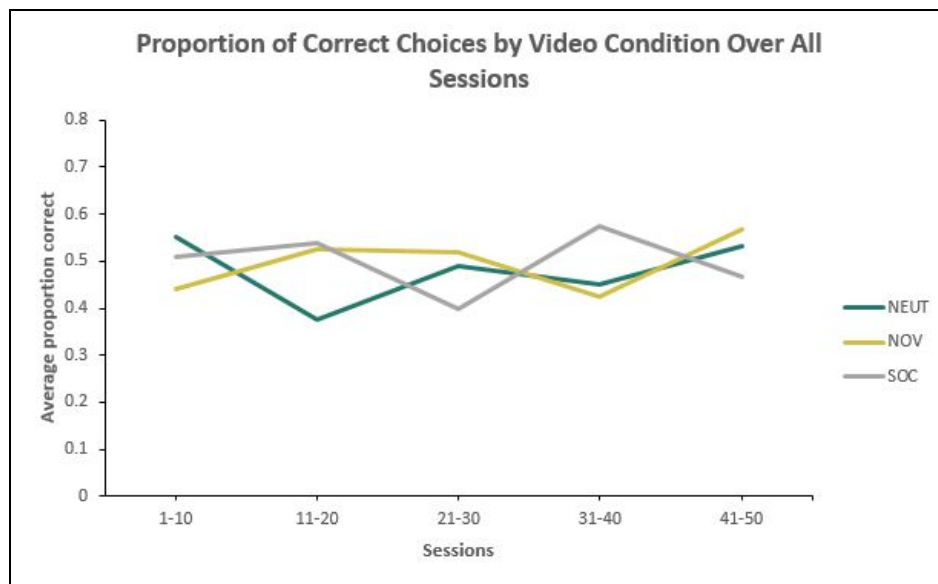


Figure 1 - Line chart showing choice accuracy per video condition over all 50 sessions grouped by tens.

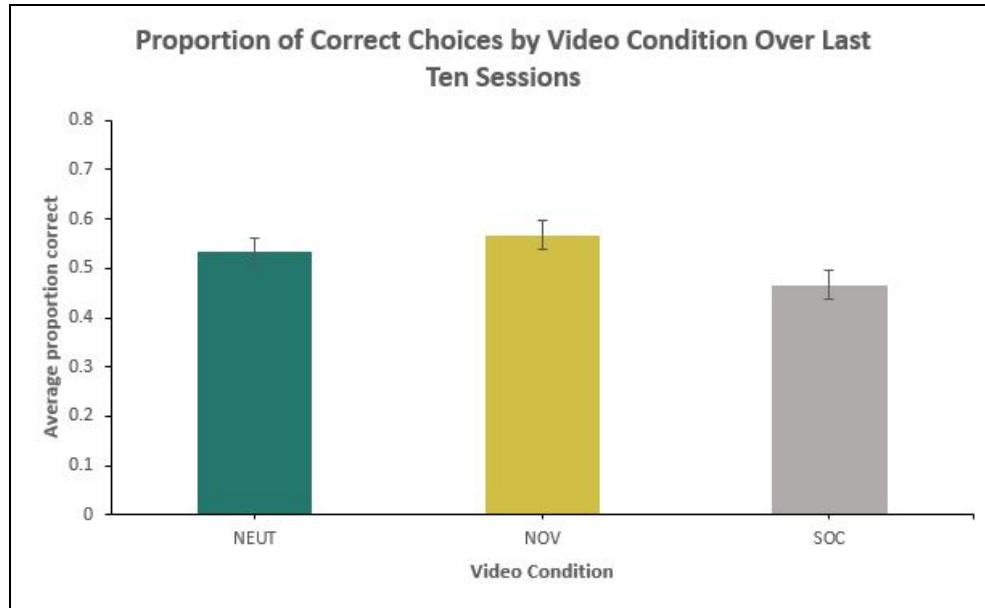


Figure 2 - Column chart showing choice accuracy per video condition overlast 10 sessions.

Discussion

Given the fact that the pigeon used in this study did not learn the task to criterion — or even beyond chance levels — it is clear that there would be no significant difference in memorization levels between the three video conditions. This is not to say that this effect does not exist, per se. Several limitations in this study may have prevented the pigeon from displaying any differential learning whatsoever. Given that the testing was conducted manually, it is possible that the pigeon was distracted by the researcher, or any objects in the lab that could be perceived visually. Inconsistencies in presentation of visual and discriminative stimuli or in delivering reinforcement may have further compounded this limitation to the study. Additionally, a majority of the food was received while not testing, which could lead to the reinforcement received while testing acting as more of a treat than a necessary component of the pigeon's diet. Improvements to the current design would include introducing an automatic testing method as opposed to a manual one; that is, instead of manual presentation of stimuli and reinforcement,

using a touchscreen for the pigeon to observe and choose stimuli, coupled with automatic processing of choices and delivery of reinforcement, may lead to less distraction, more regulation, and more control.

Due to a lack of time and personnel resources, only one pigeon could be used for this study. It may also be possible that the one pigeon used for this experiment may have sensory, perceptual, or otherwise neurological deficits that could result in its inability to learn the task. After completion of data collection for the current study, a simple red-green color discrimination task was conducted with the same pigeon to assess for any discrimination learning whatsoever. Over the course of approximately 10 sessions consisting of 30 trials each, the pigeon was not able to learn the task significantly above chance levels. This may indicate that there are sensory or perceptual deficits in the pigeon used for this study, and further behavioral and physiological experimentation may be necessary to approve participation in future studies. In order to avoid this possible confound, it may be conducive to use any of the other pigeons in the lab for further data collection in this project and future studies produced by this lab.

Improvements to the current study would include using more pigeons that have been used in a variety of behavioral discriminative tasks prior to the current study, so less time is spent on training to the task and to being in an operant chamber, and more time is spent collecting usable data. Further, increasing the sample size used in the current study would reduce the individual differences seen in the one pigeon used in the experiment, and it would be more apparent if the results obtained were due to sensory/perceptual issues seen in the pigeon or if they were due to larger-scale issues with the procedure or apparatus.

In addition, pigeons are relatively nonsocial animals, especially when compared to some mammals or other species of bird. Japanese quail and pinyon jays, for example, have a more rigidly defined and mutually beneficial social structure than pigeons do. This lack of sociality among pigeons may have led to a lack of results, even if the pigeon had learned the task. However, given the inconclusive results and small scope of this study, it is impossible to say this is the case with any certainty.

Future research may also be interested in investigating the effect of virtual computer-generated (CG) pigeons in place of recordings of live ones, as Watanabe & Troje (2006) found that pigeons are able to accurately perceive a virtual pigeon similarly to a recorded live one. This may help establish more control; even though the recorded video allows to control for in-the-moment behavior of a live nonhuman animal audience, a virtual CG pigeon would allow the researcher to control exact movements and timing of behaviors that may aid in the production of an audience effect.

It is important to study the audience effect — especially that of perceived audiences — in nonhuman animals due to its anthropocentric applications. With the rise in social media, perceived audiences in the form of follower counts, live streams, and CCTV cameras dominate much of the waking day. This may have detrimental consequences on humanity's ability to concentrate and learn concepts in real time, as the audience effect has been shown to have inhibitory effects (Huguet et al., 1999; Zentall & Hogan, 1976). Using nonhuman animals may aid in eliminating experimenter and confirmation bias in human participants.

In general, the results are too incomplete to draw any concrete conclusions; further investigation into this topic is necessary, given the limitations placed on this study.

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