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Effects of Conceptual Priming on the Perceptual Interpretation of an Ambiguous Visual Stimulus among Undergraduate Students

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ABSTRACT

The effect of priming on interpretation of an ambiguous visual stimulus (Dallenbach cow image) for undergraduate students was studied. Using a between-groups experimental design with convenience sampling, 144 undergraduate students were randomly assigned to an Animal Prime condition, a Geographic Prime condition or a Control condition. In the Animal Prime condition, participants were primed with animal-related cues prior to watching the image. For the Geographic Prime condition, the participants were asked to read the sentence "I Love Paris in the Springtime" first and then to look at the image. The control group were presented with the image without any initial priming. The responses of the participants were taped and grouped into 5 categories: Geographic, Nature, Animal, Human and Others. Using a chi-square test of independence, there was a significant relationship between the priming condition and the response category, $\chi^2(8, N = 144) = 25.98$, $p = .001$. Results indicated that priming successfully shifted participants' perceptual interpretations in the direction of the prime, with Geographic primed participants more frequently reporting geographic responses (43.1%) and Animal primed participants more frequently reporting animal responses (65.4% of all Animal responses). These findings demonstrate that conceptual priming significantly influences the interpretation of ambiguous visual stimuli, supporting theories of top-down perceptual processing and highlighting the role of prior cognitive activation in visual perception.

Introduction

Priming: when one stimulus affects the response to a second stimulus. It can impact thinking, memory, behavior and perception, sometimes without being aware of it. The initial stimulus is referred to as the prime stimulus, and it sets up related information in the brain that then is more available when the person sees the next stimulus (Litvak et al., 2025). Once the brain is "primed," it is easier to see and understand related information. People are not always objective and independent in their thinking. Instead, the brain creates perception based on previous knowledge and expectations. This implies that the stimuli an individual is exposed to actively direct the attention, retrieval of memory and interpretation. The effects are mostly unconsciously experienced; however, experiences and environmental factors continuously influence how humans perceive the surrounding world (Kornmeier et al., 2021).

Conceptual priming can be understood through several complementary cognitive theories that explain how prior knowledge shapes perception. Top-down processing theory proposes that perception is not solely determined by incoming sensory information but is actively influenced by prior experiences, expectations, beliefs, and contextual cues. From this view, the brain is constantly coding and decoding sensory information as it synthesizes new information with what it already knows, which enables people to quickly make sense of vague or incomplete data. This means that the same stimulus could be perceived differently by different observers due to the influence of the context on the perception of the stimulus, which is supported not only by the information it contains, but also by the cognitive expectations (Goldstein, 2007 & Kornmeier et al., 2021).

Schema Theory is closely related to top-down processing; it proposes that knowledge is stored in mental structures called schemas that are used to represent past experiences and concepts. These schemas are triggered when new or uncertain information is presented to the individual, enabling them to interpret or make sense of the information. Priming works by making it easier to make schema-consistent interpretations when the target stimulus is presented. So, if a person views a trigger cue from an animal or a location, they are likely to think of the animal or the location, making it more likely that the ambiguous image will be interpreted in terms of the schema that was activated (Rumelhart, 2017; Gilboa & Marlatte, 2017).

Another significant theory is Predictive Coding Theory, that suggests that perception is essentially a predictive procedure. The brain is not just receiving information from the outside environment; it is making predictions about what it is going to receive, based on the knowledge and context. These predictions are compared to actual sensory signals, and if there are any discrepancies (also called prediction errors), these are used to modify perceptual interpretations. In situations involving ambiguous stimuli, where sensory information is limited, prior expectations exert a stronger influence on perception, making conceptual priming particularly effective in biasing perceptual judgments (Friston, 2010; Clark, 2013).

Together, these theoretical perspectives provide a strong conceptual foundation for understanding how priming influences perceptual interpretation. They suggest that perception is an active constructive process in which prior knowledge, activated schemas, and predictive expectations interact with sensory input to resolve ambiguity. Based on these theories, exposure to different conceptual primes should systematically bias participants toward interpretations consistent with the activated cognitive representations (Boy, F., & Sumner,2014).

One of the most well-known ambiguous pictures is the "Dallenbach cow," which is a black-and-white photograph used to demonstrate the process of perceptual organization. If the participants have not been given the picture beforehand, they generally find it difficult to identify the cow because the picture is confusing and unclear. But when they see a picture of something they know, such as a cow, or someone tells them what the picture is, they know what it is. This shows that the brain is "primed" to recognise the figure ahead of time. Furthermore, after the image was identified as a cow, it was hard not to see it, which further demonstrates the influence of prior knowledge and schematic associations on subsequent perception (Blake & Palmisano, 2021).

There is some evidence from several studies for the effect on perceptual interpretation of priming. Litvak et al. (2025) have shown that the strength of visual illusion perception could be modulated by semantic priming, indicating that even the low-level perception was influenced by conceptual activation. They demonstrated that top-down knowledge and context information have significant influences on resolving visual ambiguity; prior knowledge would help to steer the perceptual interpretation of the image (Kornmeier et al., 2021). Likewise, Blake and Palmisano (2021) reported that cognitive style (i.e., divergent thinking) affects the perception of ambiguous visual illusions, thus highlighting the interaction between internal cognitive states and perceptual processing.

Although priming effects have been observed in a variety of contexts, there are several reports of manipulations that failed to produce a reliable priming effect. In a recent study, Brouwer et al. (2021) showed that age influences judgment, but not direct perception of ambiguous stimuli, indicating that not all individual difference variables act via the same perceptual mechanism. Weilnhammer et al. (2021) showed that perceptual history effects are also related to internal brain states, that is, that priming effects on bistable perception can be modulated by neurophysiological factors, other than the prime itself. Furthermore, Blake and Palmisano (2021) indicated that the effects of priming on perceptual outcomes may vary across individuals, as evidenced by the variable effects of priming.

Rationale

Although previous research has demonstrated that conceptual priming can influence the interpretation of ambiguous stimuli, much of the existing evidence has been generated in Western populations and laboratory settings (Kornmeier et al., 2021). Consequently, there is limited understanding of whether these perceptual effects generalize to undergraduate students from different cultural and educational backgrounds. Given that perception is shaped by prior experiences, knowledge structures, and environmental influences, examining priming effects among Pakistani university students can contribute to the cross-cultural understanding of top-down perceptual processes (Scocchia et al., 2014).

The reason for using the Dallenbach cow image for the present study was that this was one of the most familiar ambiguous images used in perceptual psychology. It is especially good for studying perceptual bias because it does not have a readily obvious interpretation and forces the observer to structure the information that is presented to them visually into a unified whole. Therefore, interpretations are more likely to be influenced by prior cognitive activation, contextual cues, and thus it is a good instrument for the study of priming effects (Blake & Palmisano, 2021).

In addition, the study compared animal and geographic priming to see if there is any difference in the way perception is influenced by the two types of conceptual information. Animal related cues were expected to elicit schemas related to living things, while geographical cues were expected to elicit schemas related to geography, landscape and maps. It is interesting, however, to compare both conceptually different primes before a single priming condition, in order to evaluate the effect of the different cognitive structures on the interpretation of the same ambiguous stimulus.

Thus, the present study was designed to find out the effect of animal priming and geographic priming on perceptual interpretation of the cow image among undergraduate students of Pakistan. The study is a contribution to the growing literature on priming, perceptual bias, and top-down processing, and it provides evidence from a population that is poorly represented in experimental perception studies.

Objectives

To examine whether different conceptual priming conditions influence undergraduate students' interpretation of the Dallenbach Cow image.

Hypothesis

Students exposed to animal-related priming cues will be significantly more likely to interpret the ambiguous image as an animal than participants exposed to geographic priming or no priming.

Method

Research Design

The effect of priming on the perception of an ambiguous visual stimulus was investigated using a between-groups design. The participants were randomly placed in one of three conditions: an Animal Prime condition, a Geographic Prime condition, or a Control condition. The independent variable was the priming condition, and the dependent variable was participants' interpretation of the ambiguous image.

Participants

Fourteen-four undergraduate students were involved in the study. The sample had a mean age of 21.01 years (SD = 2.48, range: 18–30). There were almost equal numbers of males (73, 50.7%) and females (71, 49.3%). In terms of birth order, the majority were middle born (42.4%), followed by first-born (34.7%), last-born (21.5%), and only-children (1.4%). The majority of the participants were non-working (65.3%). Participants were recruited using convenience sampling and subsequently randomly assigned to one of the three experimental conditions and their participation was voluntary. Data collection was done with informed consent. The demographic characteristics are shown in Table 1.

Table 1: ***Demographic Characteristics of Participants (N = 144)***

Variable	Category	N	%
Gender	Male	73	50.7
	Female	71	49.3
Birth Order	First-Born	50	34.7
	Middle-Born	61	42.4
	Last-Born	31	21.5
	Only Child	2	1.4
Working Status	Working	50	34.7
	Non-Working	94	65.3

Note. Participants were undergraduate students recruited through convenience sampling.

Procedure

Participants were recruited through convenience sampling from a university and were tested after providing informed consent. Data collection was conducted in a quiet psychology laboratory and participants completed the study individually to minimize discussion or influence from others. Following recruitment, participants were randomly assigned to one of three experimental conditions: Animal Prime, Geographic Prime, or Control using the fish bowl method. Folded slips representing each condition were placed in a bowl, and each participant randomly selected one slip to determine their group assignment.

In the Animal Prime condition, participants were instructed to think of and write down the names of five animals before viewing the ambiguous image. In the Geographic Prime condition, participants were instructed to carefully read the sentence *"I Love Paris in the Springtime"* before viewing the image. Participants in the Control condition were presented with the ambiguous image without receiving any prior priming task.

Following the priming activity, participants were given a picture of the cow called Dallenbach, and they were asked the standardized question, "What do you see in this picture?" Participants were asked to give their initial reactions without consulting others. The researcher took notes on their verbal responses which were later classified into five response categories: Animal, Geographic, Nature, Human, and Others. For all participants, the same instructions and testing procedure were used, except for the priming condition the participants were assigned to.

Measures

The main stimulus used in this study was the Dallenbach cow image, that is, the ambiguous black and white visual figure that can be seen in various ways depending on the clues and previous cognitive activation. The answers the participants provided to the picture were recorded and grouped according to the type of interpretation.

Data Analysis

Participants' responses were summarized using descriptive statistics over the three experimental conditions. The test of independence using the chi-square statistic was used to determine if the distribution of response categories was significantly different between the Animal Prime, Geographic Prime and Control groups.

Ethical Considerations

This study followed ethical guidelines for research on human subjects. Data collection was conducted at their own will, and informed consent was given prior to the collection of data. The participants were told they had the right to drop out of the study at any time without affecting their rights to the results of the study. The answers were kept confidential and anonymous during the research process.

Results

Participants' responses to the Dallenbach cow image were categorized into five groups. The most frequent response category was Geographic (n = 65, 45.1%), followed by Nature (n = 29, 20.1%), Animal (n = 26, 18.1%), Human (n = 16, 11.1%), and Others (n = 8, 5.6%). This overall pattern suggests that, across the full sample, participants most commonly interpreted the ambiguous image in geographic terms. The frequency distribution of response categories is presented in Table 2.

Table 2: ***Frequency Distribution of Response Categories (N = 144)***

Response Category	**N**	**%**
Geographic	65	45.1
Nature	29	20.1
Animal	26	18.1
Human	16	11.1
Others	8	5.6

Note. Percentages are based on a total of 144.

The response patterns for the three groups were very different, as illustrated in Table 3; Control: R1 Group, Experimental: Geographical prime: I Love Paris in the Springtime, Experimental: Animal prime: list of five animals. Responses in the Control Group were more evenly distributed with the highest number of responses being Geographic (23.1%), followed by Nature (41.4%) and Human (62.5% of all Human responses were from this group), suggesting that when not primed the subjects were more relying on unguided perceptual interpretation.

The number of Geographic responses was significantly greater (43.1%) in the Experimental Group (Geographic prime) than in the Control Group, showing that priming with a geographic cue was able to shift the perception of participants, facilitating the interpretation of the image as a geographic image or geographic feature. The results from the Experimental Group (Animal prime) showed that the priming with words related to animals increased the likelihood of the

participants seeing the ambiguous image as animal, which was overwhelming (65.4% of all Animal responses).

Table 3: ***Crosstabulation of Group Condition by Response Category (N = 144)***

Group	Animal n (%)	Human n (%)	Geographic n (%)	Nature n (%)	Others n (%)
Control	6 (23.1)	10 (62.5)	15 (23.1)	12 (41.4)	4 (50.0)
Exp. (Geographic)	3 (11.5)	4 (25.0)	28 (43.1)	11 (37.9)	2 (25.0)
Exp. (Animal)	17 (65.4)	2 (12.5)	22 (33.8)	6 (20.7)	2 (25.0)

Note. Exp. = Experimental. Percentages are column percentages, indicating the proportion of each response category contributed by each group. $\chi^2(8, N = 144) = 25.98$, $p = .001$.

Table 4: ***Chi-Square Test of Independence: Groups × Response Category***

Statistic	Value	Df	*p*
Pearson Chi-Square	25.979	8	.001
Likelihood Ratio	25.686	8	.001
Linear-by-Linear Association	4.712	1	.030

Note. $\chi^2(8, N = 144) = 25.98$, $p = .001$. V= .31

To investigate this relationship, a chi-square test of independence was carried out to test the association between response category and the type of priming condition (Table 4). This is statistically significant, $\chi^2(8, N = 144) = 25.98$, $p = .001$, with the distribution of the response categories being different for the three priming conditions. The association was of moderate magnitude, as indicated by Cramer's $V = .31$. This was also supported by the likelihood ratio (25.686, $p = .001$). The linear-by-linear association was also significant (4.712, $p = .030$), indicating a systematic directionality of the responses as a function of the condition.

Discussion

The present study examined whether conceptual priming influences the perceptual interpretation of an ambiguous visual stimulus among undergraduate students. The findings demonstrated a significant association between priming condition and participants' interpretation of the Dallenbach cow image, indicating that prior conceptual activation influenced the way the ambiguous image was perceived. Participants exposed to animal-related cues were considerably more likely to interpret the image as an animal, whereas those exposed to geographic cues more frequently perceived geographic features. The study hypothesis is corroborated by the findings: Perception is not only a passive reception of sensory information; it is an active process influenced by previous experiences, expectations, and context (Kornmeier et al., 2021).

The behavior of the control group can help us understand what people do when there are no cues available to help them interpret ambiguous information. When the participants were not primed, they gave a much greater diversity of responses, with the geographical and nature-related

interpretations being most common. This increased variability indicates that, in the absence of a pre-existing concept to be activated, people will use their experiences, existing knowledge, and internal schemas to make sense of ambiguous stimuli. These results support theories of top-down processing, which suggest that perception relies on the interplay between the sensory information and the stored knowledge, rather than the sensory information alone (Goldstein, 2007). Likewise, Schema Theory would predict that when new information is presented, individuals will try to make meaning of it using their existing schemas, which would be reflected in the different interpretations found in the control group (Gilboa & Marlatte, 2017).

Further evidence of conceptual priming on perceptual interpretation is found in both experimental groups. The participants who were given the geographic prime were significantly more likely to recognize the maps, landscapes or geographical features, while those who received the animal prime tended to identify the hidden animal in the Dallenbach cow image. The results indicate that the schema-consistent concepts guided the participants to make schema-consistent interpretations of the ambiguous stimulus. The pattern is similar to previous research showing that semantic and conceptual priming benefit the processing of ambiguous visual information by priming relevant schemas prior to stimulus presentation (Litvak et al., 2025; Daelli et al., 2010). Similarly, Poom and Matin (2022) found that prior perceptual information is able to affect perceptual interpretation of ambiguous stimuli, a result which also demonstrates the interplay of top-down and bottom-up processes.

The present findings are also consistent with Predictive Coding Theory, which proposes that the brain continuously generates predictions about incoming sensory information based on previous experiences and contextual information (Clark, 2013; Friston, 2010). When sensory input is ambiguous, these predictions exert a stronger influence on perception, allowing conceptual primes to bias interpretation toward expected outcomes. In the present study, participants appeared to interpret the same visual stimulus differently because the priming tasks activated different cognitive expectations before viewing the image. These findings therefore provide further support for the notion that perception is an active, constructive process rather than a direct reflection of external reality.

Although the findings support the effectiveness of conceptual priming, they should be interpreted with appropriate caution. Research on priming has produced mixed evidence, with several large-scale replication studies reporting that some social priming effects are difficult to reproduce (Mac Giolla et al., 2024). Similarly, Rotella et al. (2021) failed to replicate the well-known "watching eyes" effect, suggesting that priming effects may depend on the nature of the task, the type of prime employed, and methodological differences across studies. Unlike many social priming paradigms, however, the present study examined perceptual priming, which is generally considered to produce more robust and reliable effects because it directly influences the interpretation of sensory information rather than complex social behaviours (Gillath et al., 2022). Therefore, the significant findings observed in the present study contribute additional evidence supporting the role of conceptual priming in shaping perceptual judgments while acknowledging the broader debate surrounding the replicability of priming research.

Overall, the findings highlight the important role of prior knowledge and contextual information in shaping visual perception. In contrast to visual processing, people make sense of what they see, processing sensory information and connecting it to their existing cognitive representations. These results are not only important for theories of communication, education, and eyewitness

perception, but they also have implications for theories and practice in clinical psychology and advertising, as well, because they suggest that subtle contextual factors can affect the way people process uncertain or ambiguous information (Gillath et al., 2025). Further experiments using other ambiguous stimuli, manipulation checks, eye-tracking, and larger and more varied samples would further elucidate the mechanisms by which conceptual priming affects visual perception.

Conclusion

This study investigated the effect of pre-exposure to conceptual information on the perceptual interpretation of an ambiguous visual image in undergraduate students. The results confirmed the importance of priming in directing perception with participants in the Animal Prime condition significantly more likely to report an animal perception of the Dallenbach cow image (65.4% of all animal responses) and participants in the Geographic Prime condition significantly more likely to report a geographic perception of the Dallenbach cow image (43.1% of all geographic responses). This was contrasted with the control group who had a wider, more even distribution of responses indicating that without priming, they activated a larger set of perceptual associations. These differences across conditions were found to be significant using the chi-square test of independence: $\chi 2(8, N = 144) = 25.98$, $p = .001$. These results are combined with the previous results, which suggested that perception of ambiguous stimuli is not stimulus driven. Instead, what a person sees depends on what he or she has recently observed or learned, what he or she knows, and what he or she expects to observe or learn. The image of the cow by Dallenbach is particularly useful because it has no single correct interpretation, thus providing a nice example of the active construction of a visual experience as a top-down process in cognition. These results are also in line with the broader literature in which it has been found that context and prior activation impact perceptual results, and they help to explain how the brain will fill in the gaps when presented with an uncertain situation in order to draw on available cognitive frameworks.

Limitations

There are a number of caveats to the current study.

Firstly, the sampling was carried out using convenience sampling, so the results cannot be generalized to other age groups, educational levels and cultures. There is a possibility that the Dallenbach cow image can be interpreted differently by individuals of different backgrounds and/or with different prior exposure to such images.

Second, the study used only one ambiguous stimulus, and it is unclear whether the priming effects found in this study would be replicated with other types of ambiguous images. However, other stimuli may activate different perceptual and cognitive processes and inferences drawn from one image should be taken with a pinch of salt.

Third, the two priming conditions were not structurally equivalent: the Geographic Prime group was given a complete sentence, whereas the Animal Prime group named five animals. The difference in format could have led to some confounding factors that affected the differences in the results of the response patterns, which might not have been related to the conceptual content of the prime.

Fourth, the study measured participants' responses only immediately following the image; thus, it is not possible to infer whether the priming effects lasted over time.

Fifth, individual differences were not assessed or controlled (e.g., cognitive style, personality or prior stimulus knowledge). Previous studies have found that susceptibility to priming effects is modifiable by other factors like divergent thinking (Blake & Palmisano, 2021), which should be incorporated in future research. Finally, in the literature, there is a debate whether the priming effects are replicable or not as several large-scale replication studies have not found significant effects (Mac Giolla et al., 2024). This general concern for the replicability should be tempered by the confidence placed in the conclusions reached from the current findings.

Recommendations

The limitations discussed above should be explored in future research to build up the evidence for priming effects in visual perception.

For instance, format of the priming condition should be standardised across the two groups to remove format as a confounding variable, as both groups could receive either a sentence or a word list. It would also be helpful to have a controlled exposure time for the prime (5–10 seconds) to ensure consistency between participants and to ensure that the final judgement was not over riding the priming effect due to prolonged deliberation.

Second, it is suggested that future studies should use more diverse samples (by age, education, and cultural backgrounds) to increase the external validity of the results.

Thirdly, individual difference variables like cognitive style, divergent thinking, and prior knowledge of the stimulus should be assessed and included in analyses because they have been demonstrated to influence perceptual priming effects (Brouwer et al., 2021; Blake & Palmisano, 2021).

Fourth, the use of several ambiguous stimuli would enable researchers to determine whether the priming effect on perception would extend to the Dallenbach cow image.

Fifth, the combination of objective measures of initial fixation and early perceptual processing (e.g., eye tracking) with verbal reports would yield more specific data concerning initial fixations and early perceptual processing that would help clarify the mechanisms by which top-down priming affects the resolution of visual ambiguity.

Finally, the presence of a manipulation check would ensure that the data obtained from the manipulation was indeed the product of a genuine activation of the participants' 2nd person perspective towards the image, thereby increasing the internal validity of the experimental design.

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