Navigating the Complexities of Animacy Perception: Unraveling the Interplay of Bottom-Up and Top-Down Influences

Hengli Li
Yuanpei College
Peking University
2000017754@stu.pku.edu.cn

Abstract

We explore animacy perception, examining the interplay between bottom-up (sensory) and top-down (cognitive) processes. Motion is highlighted as a key factor in bottom-up mechanisms, while prior knowledge and social context are discussed in the context of top-down influences. We emphasizes the synergistic relationship between these processes and notes challenges faced by purely data-driven models in capturing the nuanced nature of animacy perception. Overall, the paper advocates for a holistic approach that considers both sensory input and higher-level cognitive factors in understanding animacy.

1 Introduction

The perception of animacy constitutes a fundamental dimension of human cognition, exerting profound influence over our interactions with the environment and the entities inhabiting it. Previous studies[3, 2, 5] contribute valuable insights into the perceptual causality, apparent behavior, and psychophysics underlying animacy perception. The ongoing discourse surrounding whether this cognitive process is primarily driven by bottom-up, top-down mechanisms, and a synergistic interplay of both, remains a focal point of interest for researchers. In this study, we delve into specific facets of bottom-up and top-down processes that exert influence on animacy perception. Moreover, through empirical investigation, we demonstrate that the current state of data-driven methodologies faces significant challenges in comprehending animacy due to the inherent characteristics of these fundamental cognitive processes.

2 Bottom-Up Processes for Animacy

The examination of perceptual causality underscores the intricate dynamics inherent in animacy perception, with a specific emphasis on the predominant role played by bottom-up processes. In this context, animacy perception becomes inextricably linked to the amalgamation of sensory information and environmental cues. It is noteworthy that motion emerges as a central and pivotal determinant in the attribution of animacy to objects within the visual field. Studies conducted by Scholl and Tremoulet [3] underscore the paramount importance of motion in shaping perceptions of animacy. Functioning as a salient cue, motion triggers cognitive processes culminating in the ascription of animacy. Objects in motion are frequently perceived as more animate, with the trajectory and coherence of motion significantly contributing to the perceived animacy of an entity. These findings align with the observations derived from the psychophysics of chasing [1], further accentuating the critical role played by motion coherence and trajectory in animacy perception. Moreover, the scholarly work of Shu et al. [4] delves into the nuanced facets of motion within animacy perception. The experiments conducted by them elucidate that motion patterns extracted from videos can convey anthropomorphic cues to human observers. Such findings highlight the intricate nature of animacy perception, wherein motion functions not merely as a perceptual cue but as a dynamic element that

significantly contributes to conveying anthropomorphic qualities. In essence, the bottom-up processes inherent in animacy perception, particularly those related to motion, elucidate the multifaceted manner in which sensory information shapes cognitive attributions of animacy.

3 Top-Down Processes For Animacy

Top-down processes, encompassing factors such as prior knowledge, expectations, and social context, emerge as critical determinants in shaping animacy perception, as elucidated by a convergence of insights from diverse studies. The Unified Psychological Space Framework, proposed by Shu et al. [5], provides a comprehensive perspective on the interplay between physical and social events in the context of animacy perception. This framework posits a shared cognitive mechanism, suggesting that humans employ a unified mental process for processing both types of events. This unification implies a top-down influence on animacy perception, where pre-existing cognitive structures contribute to the interpretation of animate entities in diverse contexts. Within the framework proposed by Shu et al. [5], a notable focal point is the introduction of an energy function, specifically defined as the value function for social events modeling. This energy function represents a quantitative measure of the perceived significance of social events, underscoring the role of top-down processes in assigning value to animacy-related stimuli. The incorporation of such cognitive constructs into the framework enhances our understanding of how higher-level cognitive processes contribute to animacy perception. Furthermore, additional layers of evidence reinforcing the importance of top-down processes in animacy perception are provided by Heider and Simmel [2] and Scholl and Tremoulet [3]. Heider and Simmel [2] delves into the basic functions of social perception in the context of animacy, emphasizing the attribution of intentionality and social characteristics to geometric shapes, even in the absence of explicit social cues. This underscores the role of prior knowledge and social expectations in shaping animacy attributions.

4 Interactions Between Bottom-Up and Top-Down Processes

The interaction between the two process plays a pivotal role in animacy perception. Consider a scenario wherein two objects engage in a pursuit. The immediate motion cues, including trajectory and speed, contribute to the bottom-up processes that initially inform animacy perception. However, the interpretation of this motion is significantly influenced by top-down processes that consider the broader context. If these objects are situated in an environment where pursuit is commonplace, as in a game or a chase scene, the perceived animacy might be heightened. Conversely, if the same motion occurs in an unexpected or incongruent context, top-down processes might temper animacy attribution. Thus, the integration of both bottom-up and top-down cues is imperative for a nuanced and contextually appropriate understanding of animacy.Furthermore, the relationship between objects, including their spatial proximity, can impact animacy perception. Objects moving in close proximity may be perceived as more interconnected and, consequently, more animate. This relational context adds a layer of complexity to animacy perception, where the spatial arrangement of objects becomes intertwined with both sensory input and cognitive expectations. The holistic comprehension of animacy, therefore, arises from the synergy between bottom-up and top-down processes. While bottom-up processes provide the initial, rapid assessment of animacy based on sensory input, top-down processes refine and shape this perception through the incorporation of contextual knowledge, expectations, and social considerations. This integration enables humans to navigate a dynamic and ever-changing visual environment, attributing animacy to objects in a manner not solely dictated by immediate sensory cues but deeply influenced by cognitive and contextual factors.

5 Can a Purely Data-Driven Model Solve the Problem?

Despite the considerable success that data-driven models have demonstrated in diverse domains, the complex and context-dependent nature of animacy perception presents challenges for exclusively data-driven approaches. The seamless integration of bottom-up and top-down processes necessitates a level of abstraction and contextual comprehension that may prove challenging for data-driven models to attain. Furthermore, the inherent variability in human perception, influenced by cultural, social, and individual differences, introduces an additional layer of complexity. A purely data-driven model may

encounter difficulties in generalizing across diverse contexts and accurately capturing the features inherent in animacy perception.

6 Conclusion

In conclusion, animacy perception is a multifaceted cognitive process influenced by a dynamic interplay between bottom-up and top-down mechanisms. The studies examined in this report highlight the importance of both sensory information and higher-level cognitive processes in shaping perceptions of animacy. While data-driven models have their merits, a comprehensive understanding of animacy perception requires a holistic approach that incorporates the richness of contextual information and the intricacies of human cognition.

References

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