Does Cognitive Estimation Precede Visual Experience in the Perception of Object Shape and Material, or Do They Occur Independently and Concurrently?

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Abstract

The relationship between cognitive estimation and visual experience remains a fundamental question in perceptual psychology. This dissertation explores whether cognitive processes influence our initial visual experience of objects or if they operate independently and concurrently. Revisiting Thouless's seminal work on perceptual constancy, we employed a modern experimental approach involving three participants who made judgments about the roundness of a mug's rim viewed from different angles. The findings indicate that cognitive estimation significantly influences visual experience, particularly under challenging conditions where visual tasks are complicated by perspective distortions. In the majority of conditions tested, participants' perceptions deviated significantly from objective equality, suggesting that cognitive processes shape how we perceive intrinsic object properties. These results support the integrated approach to perception, where cognitive and sensory processes dynamically interact. This research contributes to a comprehensive theory of perception, highlighting the critical role of cognitive factors in maintaining perceptual constancy and shaping visual experiences. Further studies with larger and more diverse samples, as well as the incorporation of neuroimaging techniques, are recommended to deepen our understanding of the neural mechanisms underlying these interactions.

Introduction

The relationship between visual experience and cognitive estimation when viewing objects remains a fundamental question in perceptual psychology. Vision involves the initial sensory processing of an object's features, such as its shape, color, and texture, as captured by the eyes and transmitted to the brain. Cognitive estimation, on the other hand, involves higher-level processes where the brain interprets these sensory inputs to form a coherent understanding of the object's intrinsic properties, such as its true shape, material composition, and function. This dissertation explores whether our estimation of an object’s intrinsic properties comes before or after our visual experience of the object. The central question is whether cognitive processes influence our initial visual experience or if they operate independently, or if they interact in a more complex manner, potentially occurring in parallel or influencing each other reciprocally (Palmer, 1999).

Historically, thinkers like Aristotle, von Helmholtz, and contemporary vision scientists like Mark McCourt, posited that visual experience must precede cognitive estimation. Aristotle suggested that perception starts with the reception of sensory data, which is then processed by the mind to form an understanding of the object. Von Helmholtz, a pioneer in the field of physiological optics, emphasized that perception involves unconscious inferences, where the brain interprets sensory inputs based on prior knowledge and experiences (Helmholtz, 1867). McCourt built on these ideas, arguing that visual experience provides the raw data that the cognitive system needs to interpret the physical properties of objects (McCourt, 2001). Robert H. Thouless's work on phenomenal regression to the real object significantly contributed to this debate, presenting evidence contrary to the positions of Aristotle, von Helmhotz, and McCourt, by demonstrating that visual experiences are influenced by knowledge of an object's true shape, indicating a compromise between retinal images and cognitive estimations (Thouless, 1931). Thouless's experiments showed that when subjects viewed an inclined circle, they often perceived it as more circular than it should have appeared from a perspectival projection onto the retina , suggesting that cognitive estimations of shape influence visual experience. This finding challenged the notion that visual experience and cognitive estimation are entirely separate processes, highlighting their interdependence.

In contemporary perceptual psychology, it is understood that both visual experience and cognitive estimation are likely occur in the cerebral cortex. Advances in neuroimaging and cognitive neuroscience have shown that regions of the brain involved in visual processing, such as the occipital lobe, are closely connected to areas responsible for higher-order cognitive functions, like the prefrontal cortex (Ungerleider & Haxby, 1994). This interconnectedness raises questions about the sequence and interaction between these processes. While traditional views separated experience from cognitive processes, modern research suggests a more integrated approach, where sensation and cognition are seen as dynamically interacting systems (Clark, 2013). However, the exact nature of this integration—whether cognitive estimation precedes, follows, or occurs concurrently with visual experience —remains unclear. This ambiguity necessitates experimental approaches to resolve the debate. Understanding this relationship is crucial for a comprehensive theory of perception, as it impacts how we understand the processing of complex visual environments, object recognition, and even perceptual learning and adaptation.

To address this research question, it is essential to examine contemporary studies that explore the interplay between visual experience and cognitive estimation, building on Thouless's foundational work. These studies provide insights into how perceptual constancies are maintained, how cognitive factors influence visual experiences, and the methodological approaches that can be employed to disentangle these processes. I will briefly summarize a range of contemporary studies, explain whether or not they are consistent with Thouless' position that cognitive estimates of objects' properties influence our context-dependent experience of those objects.

The paper "Stability by Degrees: Conceptions of Constancy from the History of Perceptual Psychology" by Louise Daoust explores how our perception of the environment relates to the physical facts of that environment, particularly focusing on the concept of perceptual constancy. Daoust's exploration of perceptual constancy suggests that cognitive processes contribute to perceptual stability. Perceptual constancy refers to the phenomenon where the perceived properties of an object remain relatively constant despite changes in the sensory input, such as viewing angle or lighting conditions (Daoust, 2021). Daoust's research indicates that our cognitive understanding of an object's properties, such as its shape and color, plays a crucial role in maintaining this stability. This aligns with Thouless's findings, indicating that cognitive estimation influences visual experience, leading to a more stable perceptual experience. By examining the historical context and experimental evidence, Daoust provides a comprehensive view of how cognitive processes underpin perceptual constancy, supporting the notion that cognitive estimation is integral to visual experience. In summary, Daoust's paper supports and extends Thouless's findings by discussing the historical context and philosophical implications of perceptual constancy. Both emphasize the complex nature of perception, where experiences are influenced by both proximal stimuli and the actual properties of objects, resulting in a perception that is stable to a degree but not fully invariant.

The paper "Psychological Experiments and Phenomenal Experience in Size and Shape Constancy" by Gary Hatfield explores the distinction between phenomenal experience (how objects are perceived) and cognitive assessments (beliefs about the properties of objects) in the context of size and shape constancy. Hatfield’s work distinguishes between phenomenal experiences (the immediate sensory experience) and cognitive assessments (the interpretation and understanding of those

experiences). He argues that cognitive estimation influences visual experience, shaping how we interpret and respond to sensory inputs. Hatfield’s experiments on shape and size constancy—where objects are perceived as having the same shape and size despite changes in viewing conditions—provide historical context and methodological insights, reinforcing the need to separate perceptual experience from cognitive judgments in experimental designs (Hatfield, 2014). His research highlights

the complexity of perceptual processes and the necessity of carefully designed experiments to understand the interplay between sensory inputs and cognitive interpretations. In summary, Hatfield’s paper reinforces and builds upon Thouless’s research by defending the experimental methods used to study perceptual constancy and emphasizing the distinction between how objects are phenomenally experienced and cognitively assessed. Both researchers agree on the importance of understanding the compromise between retinal images and actual object properties in perceptual constancy.

The paper "Sustained Representation of Perspectival Shape" by Jorge Morales, Axel Bax, and Chaz Firestone argues that our perception of objects retains information about their perspectival shapes (the shapes projected onto our eyes) even when we know their actual (distal) shapes. This challenges the traditional view that perception primarily reflects the true properties of objects in the world. The findings on the representation of perspectival shapes by Morales, Bax, and Firestone suggest a complex interaction between perception and cognition. Their research indicates that even when an object's actual shape is known, its perspectival shape—how it appears from a specific viewpoint—remains a significant part of the visual experience (Morales et al., 2020). This resonates with Thouless's results, showing that cognitive factors influence how we perceive shapes from different perspectives. Their studies demonstrate that the brain retains information about both the true shape and the perspectival shape, suggesting that cognitive estimation and visual experience are deeply intertwined. The research by Morales, Bax, and Firestone does extend and build on Thouless's findings by providing more nuanced evidence that perspectival shapes have a lasting impact on perception. However, it diverges by suggesting a dual representation rather than a simple compromise, indicating that both perspectival and actual shapes coexist in our perceptual experience. This adds a layer of complexity to Thouless's original concept by showing that the retinal image's influence is not merely a compromise but a persistent feature of perception.

The paper "Perceptual Constancy and the Dimensions of Perceptual Experience" by John O'Dea explores the nature of perceptual constancy and the instability of perceptual experience. The central argument is that perceptual constancy involves managing ambiguities in perceptual conditions, such as illumination or orientation, and that these experiences are structured within a complex "quality space" that captures both stable and unstable aspects of perception. O'Dea's dimensional approach to perceptual constancy complements Thouless's insights, emphasizing the interplay of stability and cognitive factors in perception. O'Dea argues that perceptual constancy involves not just the stabilization of perceived properties, but also a dynamic interaction between different dimensions of perception, such as spatial orientation and contextual factors (O'Dea, 2020). This supports the view that perceptual constancy involves complex interactions between perception and cognition. By integrating multiple dimensions of perceptual experience, O'Dea's work provides a richer understanding of how cognitive processes contribute to the stability of visual experience. O'Dea's research aligns with Thouless's foundational ideas on perceptual constancy, particularly the concept of perceptual experiences as compromises between retinal images and actual properties. However, O'Dea expands upon these ideas by introducing the framework of quality spaces and categorizing perceptual dimensions as integral or separable. This refinement provides a more detailed and structured understanding of how perceptual constancy operates, incorporating both stability and instability in perceptual experience. Overall, O'Dea's work builds on and enhances Thouless's findings, offering deeper insights into the complexity of perceptual constancy.

The paper "Are Perspectival Shapes Seen or Imagined? An Experimental Approach" by John Schwenkler and Assaf Weksler explores whether the perspectival shapes of objects (e.g., the elliptical appearance of a tilted coin) are a part of visual experience or if they are constructed in the imagination. Schwenkler and Weksler's methodology for determining if perspectival shapes are seen or imagined parallels Thouless' approach. Their experiments involve tasks that require participants to identify shapes from various perspectives, testing whether these shapes are part of the visual experience or constructed through imagination (Schwenkler & Weksler, 2018). Their work suggests that cognitive estimation might play a significant role in shaping our visual experience, a concept central to this dissertation. Their findings indicate that perspectival shapes are not merely imagined but are an integral part of visual experience, influenced by cognitive processes. Overall, Schwenkler and Weksler's research aligns with Thouless's in its focus on the complexity of perceptual experience and the factors that influence it. Both recognize that perception is not straightforwardly a reflection of the external world but is mediated by various factors, whether they be retinal images or cognitive constructions. Schwenkler and Weksler build on Thouless's foundational ideas by introducing modern experimental techniques and cognitive psychology concepts to further investigate the nature of perceptual constancy and the experience of perspectival shapes. This alignment and expansion provide a deeper understanding of how we perceive shapes and constancies in our visual environment.

The paper "The Effects of Three-Dimensional Context on Shape Perception" by Margaret E. Sereno, Kelly E. Robles, Atsushi Kikumoto, and Alexander J. Bies investigates how three-dimensional (3D) context influences the perception of shape. Sereno et al.' s study on the influence of 3D context on shape perception supports Thouless's findings about the significant role of cognitive context in visual experience. Their results highlight how 3D context aids objective shape judgment while hindering projective judgments, underscoring the importance of cognitive influences on visual experience (Sereno et al., 2020). By examining how the brain integrates three-dimensional contextual information to form stable percepts, their work provides further evidence of the interplay between cognitive estimation and visual experience, reinforcing the need for an integrated approach to understanding perceptual processes. The research by Sereno et al. builds on and extends Thouless's foundational ideas on perceptual constancy by providing more detailed and specific insights into the role of 3D context. Both sets of research underscore the complexity of perceptual processes and the interplay between retinal images and actual object properties, demonstrating that perception is influenced by various contextual and viewing conditions. Thus, Sereno et al.'s findings are well-aligned with Thouless's research, while also contributing new knowledge through advanced experimental techniques and a specific focus on 3D context.

The experiment described in this dissertation was derived from the first experiment reported in Thouless 1931 paper. Both explore how observers experience the 'roundness' of a circular object seen from a viewpoint at an angle to the object. Thouless asked his participants to draw the shape they experienced. In the current study we present our observers with a series of ellipses on a computer screen and ask them to report whether each ellipse is ‘rounder’ or ‘thinner’ than the experience elicited by the circular object. Our circular object was the rim of a Durham University Psychology Department coffee mug viewed from one of two different angles: 20 degrees and 40 degrees. The test stimuli consisted of a series of computer generated ellipses with varying degrees of roundness. Participants used buttons on the computer to indicate whether each ellipse appeared rounder or thinner than the mug's rim. At a 20-degree angle, the mug's rim was positioned further from the participants, while at a 40-degree angle, it was closer. The ellipses we generated so that one corresponded in shape to the perspective projection of a circle at the angle the mug was viewed from. There were four ellipses with progressively larger aspect ratios (i.e. they were thinner) and four with smaller aspect ratios. We used the proportion of ‘rounder’ responses made to each aspect ratio to fit a psychometric function and so estimate the shape of ellipse that corresponded to the observer’s experience.

When the mug was viewed at a 20-degree angle, its rim appeared more elliptical (thinner). In this scenario, participants were expected to rely more heavily on their cognitive knowledge of the mug's intrinsic round shape to maintain perceptual constancy. This reliance on prior knowledge is anticipated to be more pronounced in the 20-degree condition due to the greater discrepancy between the visual input and the participants' understanding of the mug's true shape. Participants might adjust their visual experience to align more closely with their cognitive estimation of the rim's roundness.

We hypothesise that in the 20-degree viewing condition, participants will report fewer 'rounder' responses, indicating a perception of the CGI stimuli as less round than the actual mug rim. This result would suggest that participants perceive the rim as rounder when it is viewed at a distance, supporting the notion that cognitive estimation of an object's intrinsic properties influences and precedes visual experience. These findings would align with Thouless's observations, demonstrating that cognitive knowledge of an object's true shape affects perceptual judgments and highlighting the interplay between cognitive processes and visual experience.

Building on these insights, the proposed experiment aims to determine whether cognitive estimation occurs before visual experience or if they occur independently or in parallel. This experiment addresses gaps and methodological issues identified in the reviewed literature, including Thouless’s study. Using modern psychophysical methods, participants will make simple binary decisions about shapes, reducing cognitive influences on their judgments. By simplifying the task to binary decisions, the experiment minimizes the potential for cognitive biases and focuses on the perceptual processes involved. This approach allows for a clearer examination of the sequence and interaction between visual experience and cognitive estimation.

The main goals of this experiment are:

- To determine whether the estimation of an object’s intrinsic properties occurs before the visual experience or if they occur independently or in parallel. This will be achieved by analysing the response times and accuracy of participants' judgments under controlled conditions.

- To assess the consistency of visual judgments across real objects and realistic computer-generated images (CGI). By comparing responses to real and CGI objects, the study aims to understand the robustness of perceptual processes and the influence of realism on cognitive estimation.

- To examine the influence of viewing conditions and decision time on visual judgments. By varying the viewing conditions and the time allowed for decisions, the experiment will explore how these factors affect the interplay between visual experience and cognitive estimation.

By integrating historical and contemporary perspectives, this dissertation aims to provide a clearer understanding of the relationship between cognitive estimation and visual experience. The proposed experiment, informed by the foundational work of Thouless and supported by modern research, seeks to clarify whether cognitive processes precede, follow, or occur concurrently with visual experience. This research contributes to the broader understanding of perceptual constancy and the cognitive processes underlying shape perception. Understanding these relationships will enhance our knowledge of how the brain integrates sensory and cognitive information to produce coherent and stable perceptions of the world.

Methodology

Design

The study employed a repeated measures design, which allowed each participant to experience both levels of the independent variable: the viewing angles of the mug at 20 degrees and 40 degrees. This design was chosen to control for individual differences in perception and ensure that any observed effects were due to the manipulation of the viewing angle rather than variability between participants. The dependent variable was the number of times participants selected the 'rounder' option when comparing the CGI discs to the real mug's rim.

Participants

Three participants (2 males and 1 female) from Durham University participated in the study. Their ages ranged from 22 to 26 years. All participants reported having normal eyesight. The small sample size was strategically chosen to address the research question efficiently, following Aristotle's principle of careful and thorough investigation with a focused group. Taking a psychophysical approach in which a small number of participants make a large number of decisions over a carefully chose range of stimuli allows statistical analyses to be conducted at the level of individual observers is likely to produce clearer results than a groups study in which smaller numbers of trials lead to inaccurate estimates of each observers experience. .

Apparatus and Materials

The experimental setup included several key components designed to ensure precision and consistency:

- **Chin Rest:** A chin rest was used to stabilize participants' heads, ensuring that their viewing angle remained constant throughout the experiment. This device was crucial for maintaining consistent eye level and minimizing head movement, which could affect perception.

- **Mug and CGI Ellipses:** A real mug was used as the reference object. The stimuli consisted of a sequence of CGI ellipses with varying degrees of roundness, designed to mimic the rim of the mug. These ellipses had black contours and were presented on a plain white background to eliminate any potential distractions or contextual influences.

- **MATLAB Programming Platform:** The experiment was controlled using MATLAB (Mathworks, N.D.), which managed the presentation of stimuli and recorded responses. MATLAB was also used to measure and adjust the distance of the mug to achieve the correct viewing angles for each condition.

- **Laptop and Stand:** The laptop displaying the stimuli was positioned on a stand to align with the participants' eye level from the table top. This setup ensured that the visual stimuli were presented consistently across trials and participants.

Procedure

The experiment was conducted individually in a well-lit laboratory at Durham University to ensure a controlled environment and consistency across participants. The procedure was as follows:

1. **Preparation:** Participants were seated comfortably at a desk and instructed to place their heads on the chin rest. The height of their eyes was measured with a tape measure, and this measurement was input into MATLAB, which then computed the correct position for the mug to achieve the desired viewing angles of 20 degrees and 40 degrees.

2. **Stimulus Presentation:** Participants were exposed to 30 blocks of trials, with 15 blocks at a 20-degree viewing angle and 15 blocks at a 40-degree viewing angle. Each block contained 90 trials (ten for each aspect ratio of ellipse), resulting in a total of 1,350 trials per viewing angle condition and 2,700 trials per participant. However, participant 1 could only complete 10 blocks of each trials for reasons of limited time. Meaning one participant did 900 trials per angle condition and 1,800 trials in total.

3. **Task Instructions:** Participants were instructed to respond to each visual stimulus (CGI ellipses) by pressing the '.' key if they perceived the disc as thinner than the mug's rim or the ',' key if they perceived it as rounder. There were no time constraints imposed, allowing participants to take as much time as needed to ensure accurate responses.

4. **Trial Execution:** Each CGI disc was displayed within the participant's eyeline, and the next disc appeared only after a response was made. This ensured that participants had sufficient time to compare each disc to the mug's rim without feeling rushed.

5. **Data Collection:** For each block, a score was recorded, reflecting the frequency with which participants pressed the ',' (rounder) key. This score indicated how often participants perceived the displayed stimuli as rounder compared to the actual rim of the mug.

6. **Consistency and Control:** The individual nature of the experiment in a controlled laboratory setting ensured that external variables were minimized, providing consistency across participants and trials.

The aim was to determine whether the cognitive estimation of an object's intrinsic properties, such as the roundness of the mug's rim, precedes or influences visual experience. By comparing responses across different viewing angles, the study sought to reveal the shape of ellipse corresponding to the observer's experience. If this shape was significantly different to the shape of the geometrically correct perspectival projection of a circle at the given viewing angle this would indicate that prior knowledge and cognitive processes affect experience, thereby contributing to the ongoing debate on the interplay between cognitive estimation and visual

experience.

Results

The points on the graph represent the proportion of trials where the participant identified the displayed ellipse on the screen as rounder than their experience of shape of the rim of the mug. The cumulative Gaussian curve fitted to these data allows us to estimate their subjective experience (the shape corresponding to the mean of the Gaussian) and the uncertainty in their decisions (the variance of the Gaussian), highlighting a gradual transition rather than a sharp change, which would indicate an absolute threshold.

The point where the fitted curve intersects the 50% mark represents the point of subjective equality (PSE), where participants would make an equal number of 'rounder' and 'not rounder' judgments. This point indicates where the shape on the screen matches the participants' experience of roundness. An PSE value of 5 in the 9 step set of stimuli we used would be expected if participants had perfect judgment, as this value represents the true point where the ellipse on the screen matches the actual shape.

Participant 1

The analysis of the 20-degree trials for Participant 1 reveals that the point of subjective equality (PSE) indicates an experience of equality when the ellipse is actually rounder, aligning with Thouless's findings. The true value of the point of objective equality falls significantly outside the 95% confidence interval (CI) of the PSE. This lack of overlap indicates a statistically significant deviation from objective equality, underscoring a perceptual shift consistent with prior cognitive estimations influencing visual experience. See Figure 1.

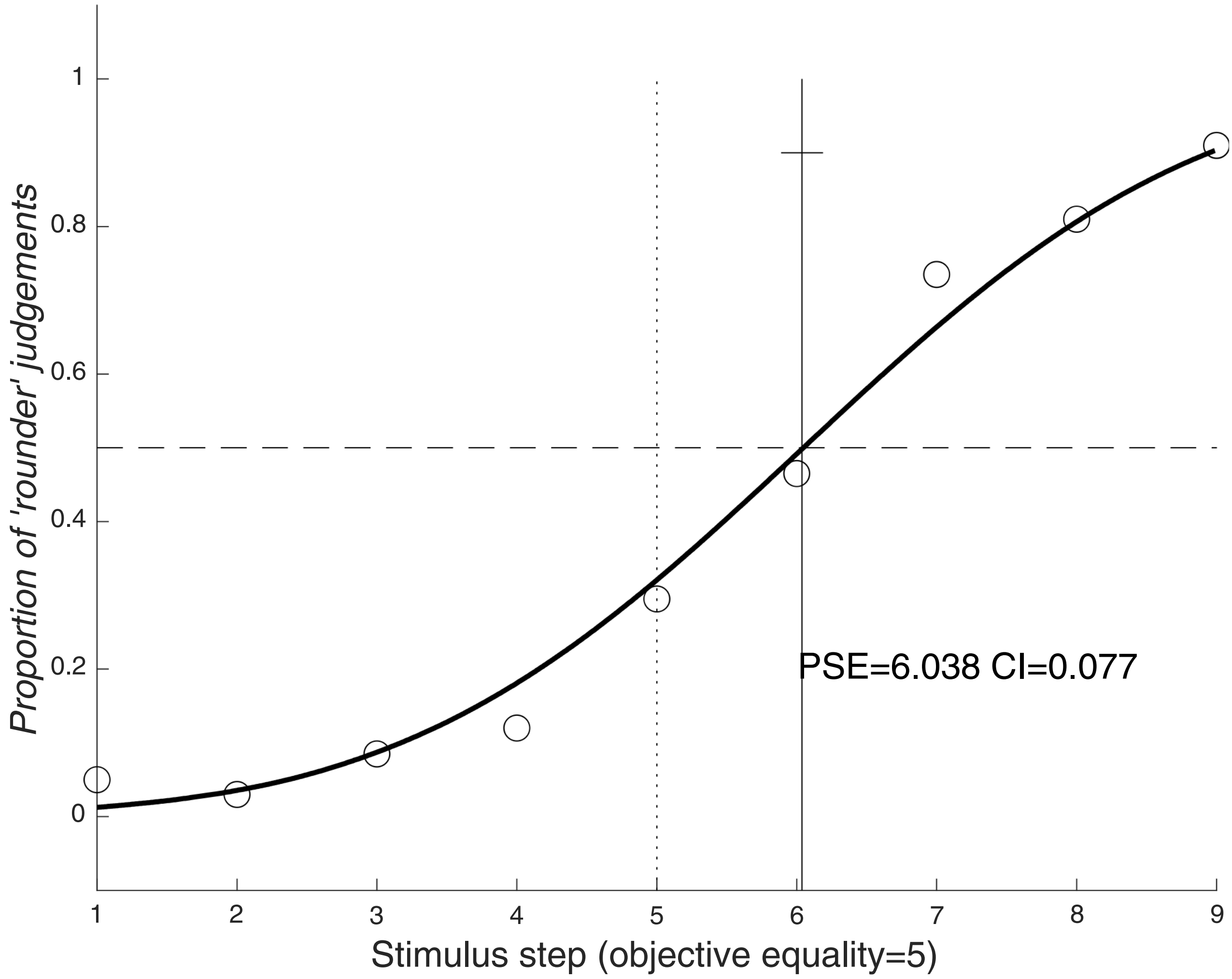

Figure 1.

In the 40-degree condition, the results diverge from Thouless's theory. Here, the point of objective equality is within the 95% CI of the PSE, indicating that the participant's perceptual judgments were closer to objective equality under this viewing angle. This suggests that cognitive estimation did not significantly distort visual experience in this condition. See Figure 2.

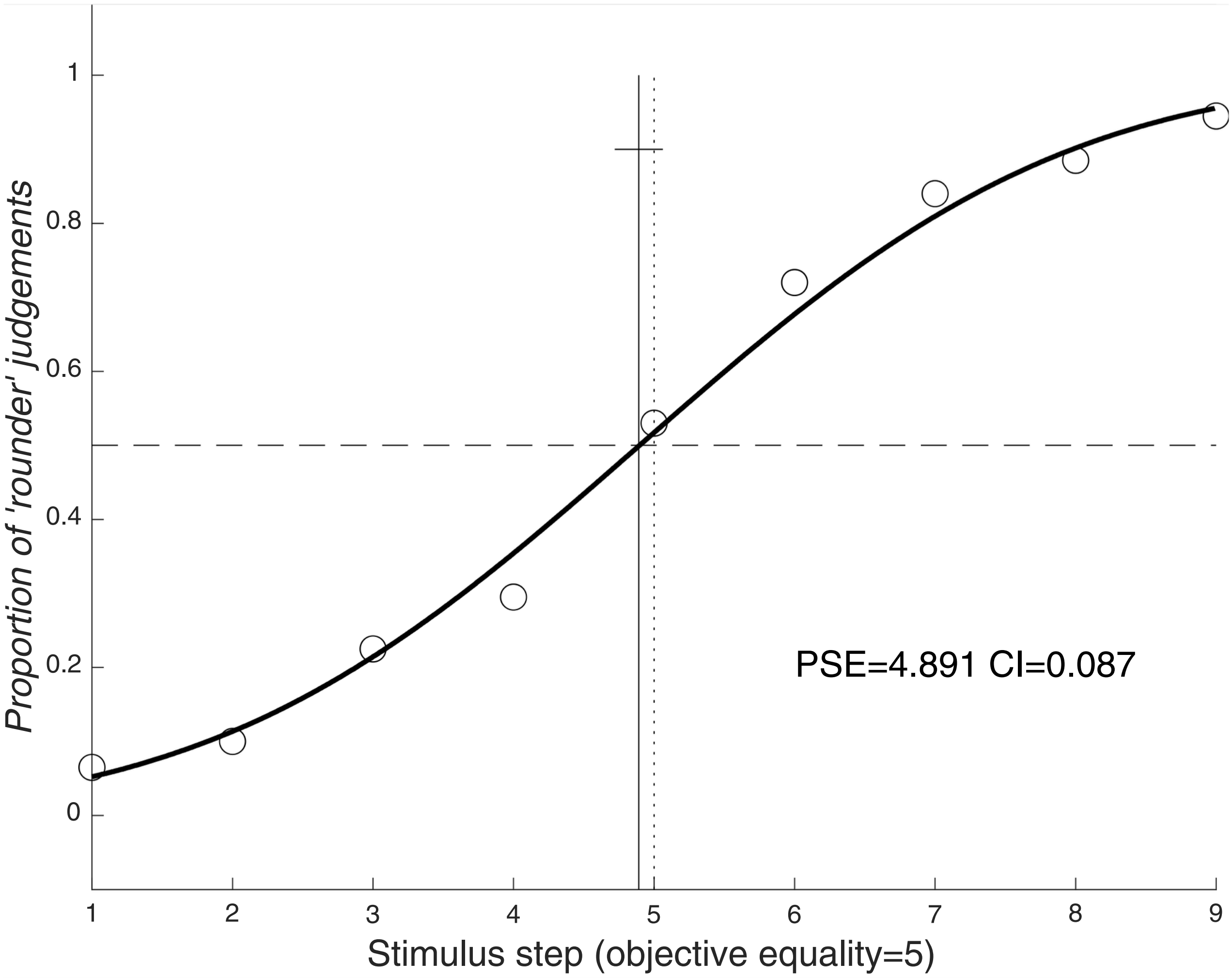

Figure 2.

Participant 2

For Participant 2, the 20-degree condition presented a substantial challenge, reflected by a large standard deviation (s.d.) in the cumulative Gaussian curve. Despite the increased difficulty and a larger CI, the PSE still shows a significant shift away from objective equality, indicating that cognitive estimations heavily influenced the participant's visual experience. The CI does not overlap with the point of objective equality, confirming this shift. See Figure 3.

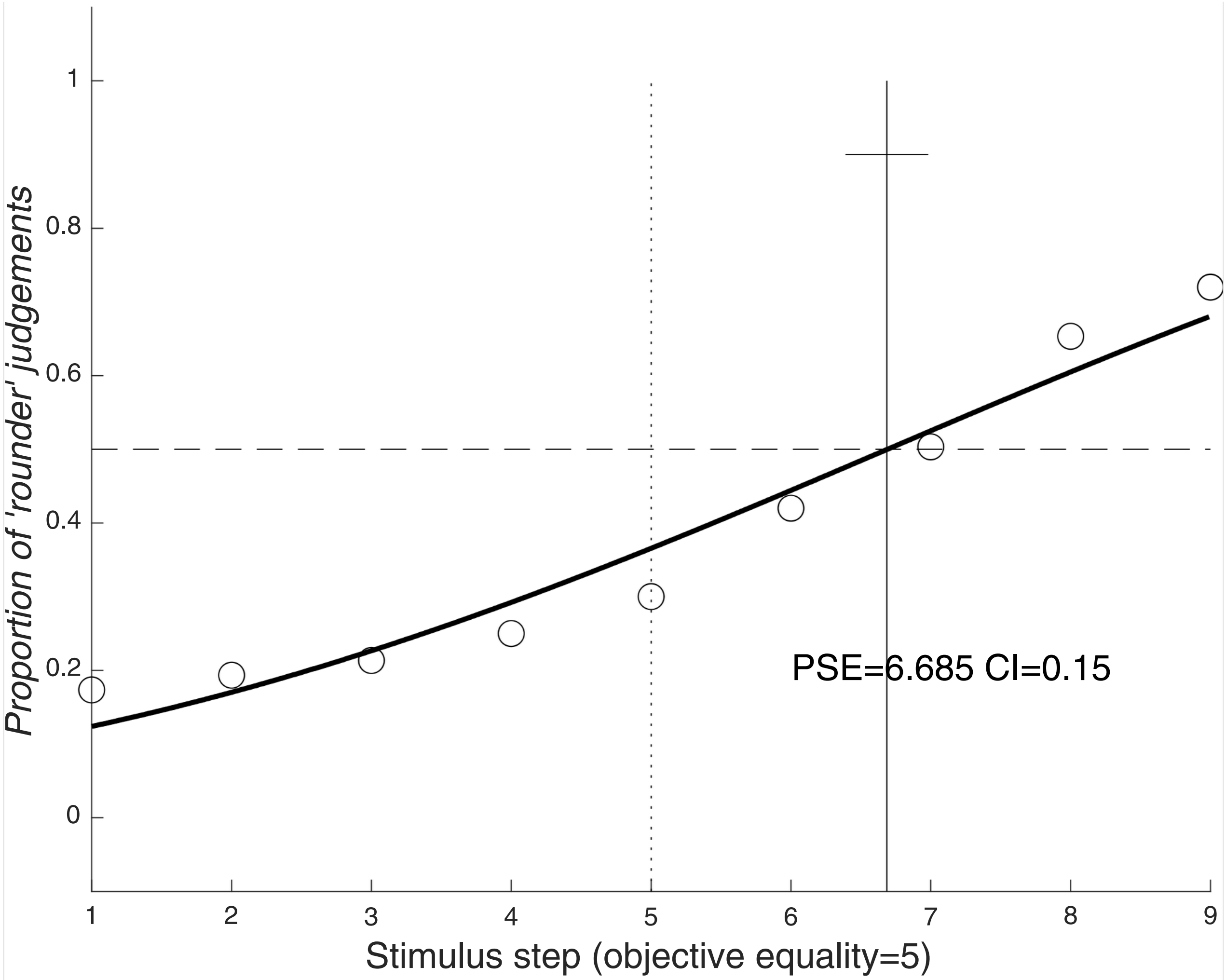

Figure 3.

In the 40-degree condition, Participant 2 exhibited a high degree of difficulty, responding almost uniformly across trials. This uniformity prevented the fitting of a meaningful curve, making it impossible to estimate the PSE accurately. This suggests that the task was too challenging for the participant, leading to consistent responses that did not vary with the stimulus. See Figure 4.

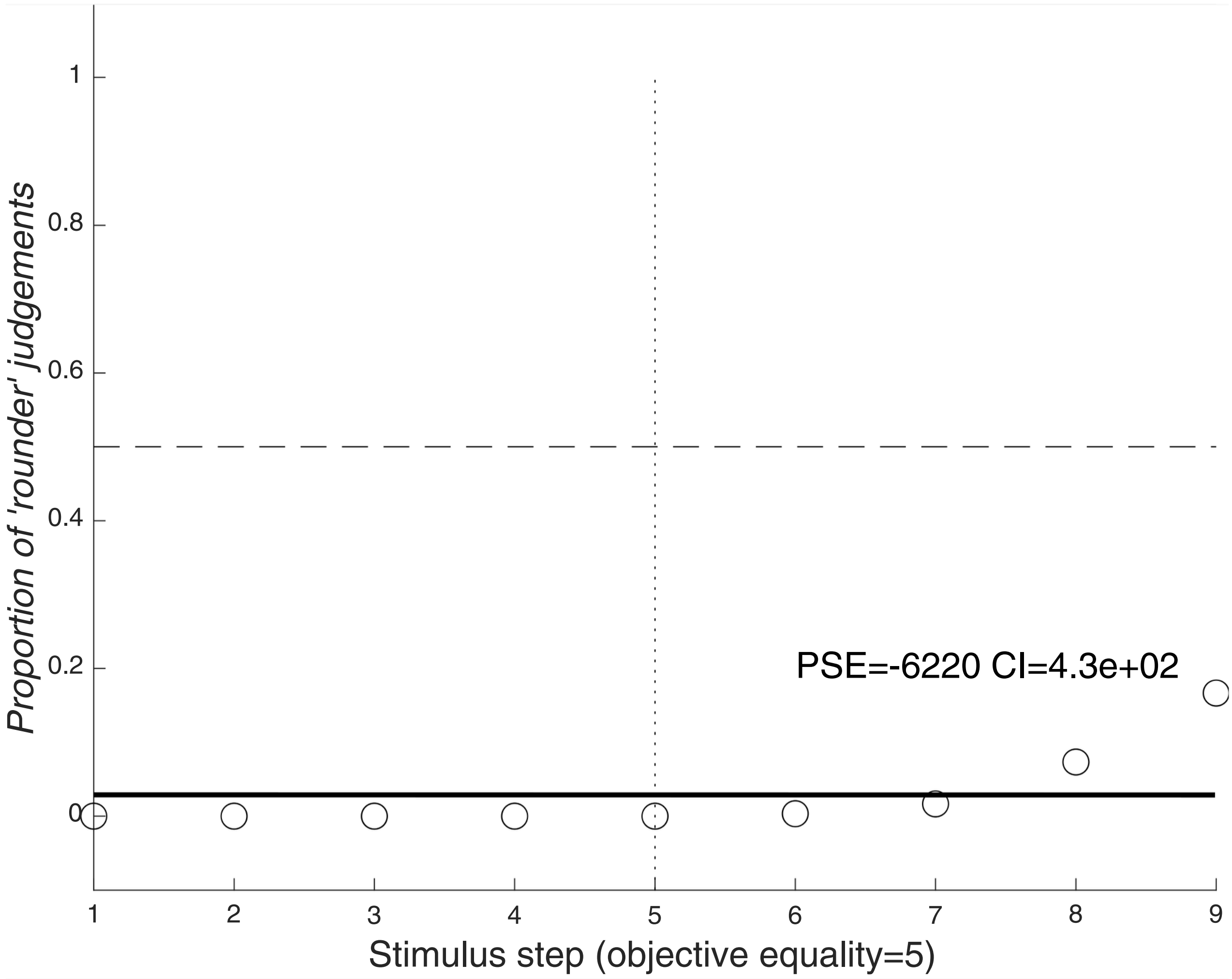

Figure 4.

Participant 3

Participant 3's results closely mirror those of Participant 1. In the 20-degree trials, the PSE indicates that the participant perceives equality when the ellipse is rounder, consistent with Thouless's findings. The true point of objective equality falls well outside the 95% CI of the PSE, demonstrating a significant perceptual shift away from objective equality. See Figure 5.

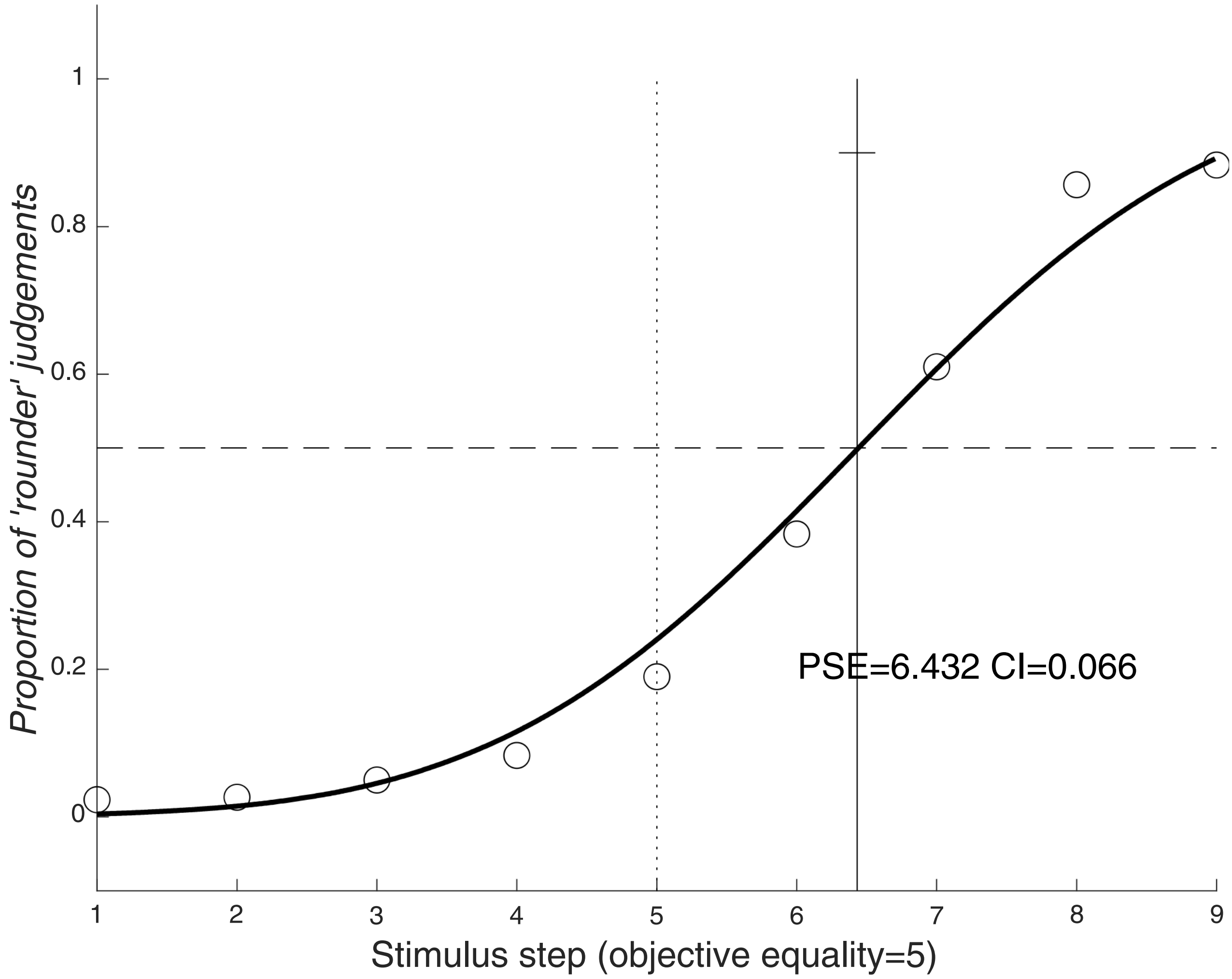

Figure 5.

In the 40-degree condition, Participant 3's PSE is significantly distant from the point of objective equality, indicating a large perceptual shift. This result aligns with Thouless's observations, suggesting that cognitive estimations significantly influence visual experience under this condition. See Figure 6.

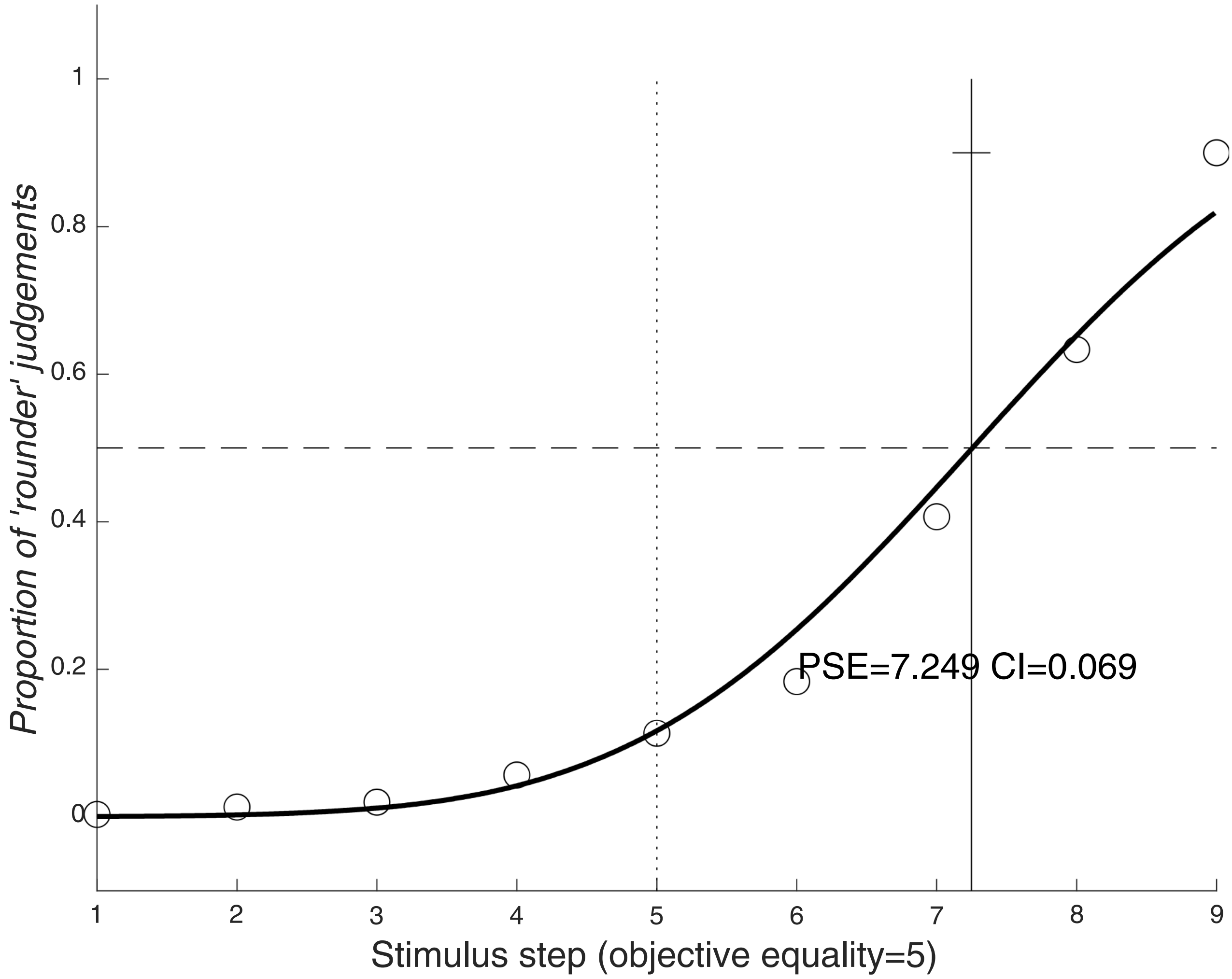

Figure 6.

Summary and Implications

We have 6 sets of data, of the 6 sets we could make estimates of the point of subject equality (PSE) in 5 sets. Of those 5 sets there are 4 sets that show absolutely clear shifts away objective equality consistent with Thouless.

Overall, the results across the three participants indicate that in 4 out of 5 measurable conditions, there is a clear shift away from objective equality consistent with Thouless's findings. These shifts suggest that cognitive estimations significantly influence visual experience, especially under conditions where the task is perceived as more difficult, such as the 20-degree viewing angle.

Given the substantial variability in task difficulty and shifts of the PSE away from objective equality, further experiments are warranted. Future studies could explore the relationship between task difficulty, foreshortening, and the size of the shift by varying the viewing angles incrementally (e.g., 10 degrees, 20 degrees, 30 degrees) to determine if the difficulty correlates with the extent of the shift. Such studies would provide deeper insights into the cognitive mechanisms underlying visual experience and the conditions under which cognitive estimations most strongly influence experience.

Discussion

The findings of this dissertation offer significant insights into the intricate relationship between cognitive estimation and visual experience. The study aimed to determine whether cognitive processes precede, follow, or occur concurrently with visual experiences. By revisiting Thouless's seminal experiments with a modern methodological approach, we have garnered evidence that supports the notion that cognitive estimation significantly influences visual experience, particularly under certain conditions.

Summary of Findings

The results show that in the majority of conditions tested (4 out of 5 measurable conditions), participants' perceptions deviated significantly from objective equality.

This suggests that cognitive estimations of an object's intrinsic properties, such as the roundness of the mug's rim, indeed influence visual experience. Specifically:

1. **20-Degree Viewing Angle**: Both Participant 1 and Participant 3 showed a significant perceptual shift, indicating that their cognitive estimations of the mug's intrinsic roundness influenced their visual judgments. This aligns with Thouless's findings and suggests that when the visual task is more challenging due to greater perspective distortion, cognitive processes play a more prominent role in maintaining perceptual constancy.
2. **40-Degree Viewing Angle**: The results were mixed. Participant 1's results suggested that cognitive estimation did not significantly distort visual experience under this condition, which contrasts with Thouless's theory. However, Participant 3 exhibited a significant perceptual shift, consistent with Thouless's observations. Participant 2, due to the difficulty of the task, was unable to provide meaningful data in this condition.

These findings suggest that cognitive estimation and visual experience interact in a complex manner, where the influence of cognitive processes may vary depending on the viewing conditions and the perceived difficulty of the task.

Implications for Perceptual Psychology

The results contribute to the ongoing debate on whether cognitive estimation precedes or follows visual experience or whether they occur concurrently. The study provides evidence that supports the integration of cognitive processes and visual experience, aligning with contemporary views in perceptual psychology that advocate for a more dynamic and interconnected understanding of perception (Clark, 2013).

1. **Perceptual Constancy**: The findings reinforce the concept of perceptual constancy, where cognitive factors contribute to the stability of visual experience despite changes in sensory input. This supports Daoust’s (2021) argument that cognitive processes underpin perceptual stability and are integral to maintaining consistent perceptions of object properties across varying conditions.
2. **Cognitive Influence on Perception**: The significant shifts observed in the 20-degree condition highlight the role of cognitive estimations in visual experience, suggesting that our understanding of an object's intrinsic properties can influence how we perceive it from different perspectives. This finding extends Thouless's work and aligns with Hatfield's (2014) and Morales et al.'s (2020) research on the interplay between sensory inputs and cognitive interpretations.

3. **Interaction of Sensory and Cognitive Processes**: The study shows that sensory and cognitive processes do not operate in isolation but rather interact in a complex manner. This interaction is particularly evident under challenging visual conditions, where cognitive estimations seem to play a more significant role in shaping visual experience. This supports the integrated approach to perception proposed by contemporary researchers like Clark (2013), who argue that perception is a dynamic interplay of sensory inputs and cognitive processes.

Methodological Considerations

The experimental design, which involved a small number of participants making a large number of decisions, provided robust statistical analyses at the individual level.

This approach allowed for a detailed examination of perceptual processes and minimized the influence of individual variability. However, the study's small sample size also presents limitations, necessitating further research with larger and more diverse participant groups to validate and extend these findings.

1. **Small Sample Size**: While the focused approach of using a small sample size with numerous trials per participant allows for detailed individual-level analysis, it limits the generalizability of the findings. Future research should involve a larger and more diverse sample to ensure that the results are broadly applicable.
2. **Task Difficulty and Variability**: The variability in task difficulty across different viewing angles highlights the need for future studies to systematically vary viewing angles and task complexities. This would help to better understand the conditions under which cognitive estimations most strongly influence visual experience.
3. **Integration of Neuroimaging Techniques**: Incorporating neuroimaging techniques in future studies could provide deeper insights into the neural mechanisms underlying the interaction between cognitive and perceptual processes. This could help to identify specific brain regions involved in integrating sensory and cognitive information during visual experience.
4. **Experimental Design Improvements**: Future experiments should consider incorporating additional control conditions and varying the types of objects and perspectives used. This would provide a more comprehensive understanding of how cognitive estimation influences visual experience across different contexts and object types.

Conclusion

This dissertation provides compelling evidence that cognitive estimation influences visual experience, particularly under conditions where visual tasks are challenging due to perspective distortions. The findings support a more integrated approach to understanding perception, where cognitive processes and visual experiences are dynamically interconnected. By building on Thouless's foundational work and incorporating modern methodologies, this research contributes to a more comprehensive theory of perception, highlighting the importance of cognitive factors in shaping our visual experiences. Understanding these relationships is crucial for advancing our knowledge of how the brain integrates sensory and cognitive information to produce coherent and stable perceptions of the world.

The study emphasizes the need for further research to explore the nuances of this interaction, including the potential for neuroimaging studies to shed light on the underlying neural mechanisms. By continuing to investigate the relationship between cognitive estimation and visual experience, we can develop a deeper understanding of the complex processes that underlie our ability to perceive and interpret the world around us.

References

Carbon, C. C. (2014). Understanding human perception by human-made illusions. Frontiers in Human Neuroscience, 8(566). https://doi.org/10.3389/fnhum.2014.00566

Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. Behavioral and Brain Sciences, 36(3), 181–204. https://doi.org/10.1017/s0140525x12000477

Daoust, L. (2021). Stability by degrees: conceptions of constancy from the history of perceptual psychology. History & Philosophy of the Life Sciences, 43(1). https://doi.org/10.1007/s40656-021-00370-1

Duan, Z., & Curtis, C. E. (2024). Visual working memories are abstractions of percepts. https://doi.org/10.7554/elife.94191.2

Eysenck, M. W., & Keane, M. (2020). Cognitive Psychology : a student's handbook. Psychology Pres.

Hatfield, G. (2014). Psychological Experiments and Phenomenal Experience in Size and Shape Constancy. Philosophy of Science, 81(5), 940–953. https://doi.org/10.1086/677891

Handbuch der physiologischen Optik : Helmholtz, Hermann von, 1821-1894 : Free Download, Borrow, and Streaming : Internet Archive. (2014). Internet Archive.

https://archive.org/details/handbuchderphysi00helm

Manassi, M., Murai, Y., & Whitney, D. (2023). Serial dependence in visual experience: A meta-analysis and review. Journal of Vision, 23(8), 18–18. https://doi.org/10.1167/jov.23.8.18

McCaffery, J. M., Robertson, D. J., Young, A. W., & Burton, A. M. (2018). Individual differences in face identity processing. Cognitive Research: Principles and Implications, 3(1). https://doi.org/10.1186/s41235-018-0112-9

McCourt, M. E. (2001). Vision Research. Annual Review of Psychology, 52(1), 617-640. https://archive.org/details/annualreviewofps0052unse

Morales, J., Bax, A., & Firestone, C. (2020). Sustained representation of perspectival shape. Proceedings of the National Academy of Sciences, 117(26), 14873–14882. https://doi.org/10.1073/pnas.2000715117

O'Dea, J. (2020). Perceptual constancy and the dimensions of perceptual experience. Phenomenology and the Cognitive Sciences. https://doi.org/10.1007/s11097-020-09705-y

Padilla, L. M., Creem-Regehr, S. H., Hegarty, M., & Stefanucci, J. K. (2018). Decision making with visualizations: a cognitive framework across disciplines. Cognitive Research: Principles and Implications, 3(1). https://doi.org/10.1186/s41235-018-0120-9

Palmer, S. E. (1999). Vision Science: Photons to Phenomenology. MIT Press.

Schwenkler, J., & Assaf Weksler. (2019). Are perspectival shapes seen or imagined? An experimental approach. Philarchive.org. https://philarchive.org/rec/SCHAPS-16

Sebo Uithol, Bryant, K., Toni, I., & Mars, R. B. (2021). The Anticipatory and Task-Driven Nature of Visual experience. 31(12), 5354–5362. https://doi.org/10.1093/cercor/bhab163

Sereno, M. E., Robles, K. E., Kikumoto, A., & Bies, A. J. (2020). The Effects of Three-Dimensional Context on Shape Perception. Journal of Experimental Psychology: Human Perception and Performance.

THOULESS, R. H. (1931). PHENOMENAL REGRESSION TO THE REAL OBJECT. I. British Journal of Psychology General Section, 21(4), 339–359. https://doi.org/10.1111/j.2044-8295.1931.tb00597.x

Ungerleider, L. (1994). “What” and “where” in the human brain. Current Opinion in Neurobiology, 4(2), 157–165. https://doi.org/10.1016/0959-4388(94)90066-3

Visual experience and visual cognition in healthy and pathological ageing. (2024). Frontiers. https://www.frontiersin.org/research-topics/862/visual-perception-and-visual-cognition-in-healthy-and-pathological-ageing

Visual experience - an overview | ScienceDirect Topics. (n.d.). Www.sciencedirect.com. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/visual-perception

Zaira, C., & Tomaso, V. (2011). The Relationship between Visual experience, Imagery, and Cognitive Functions. Blind Vision, 49–73. https://doi.org/10.7551/mitpress/9780262015035.003.0003