Comprehensive Analysis and Refinement of a Perceptual Quality Study for the Biomimeta Video Codec

1. Executive Summary

The proposed Perceptual Quality Study (PQS) for the Biomimeta video codec presents a robust and scientifically sound framework for evaluating its performance against a conventional codec, AV1. The core hypothesis, that viewers prefer Biomimeta at a given bitrate with fewer artifacts—particularly in foveated or attention-weighted regions—is well-aligned with modern approaches to video quality assessment. The study design is comprehensive, incorporating a range of psychophysical methodologies, advanced metrics, and rigorous statistical analysis plans.

This report provides a detailed, neurobiologically-grounded analysis of the proposed PQS, offering refinements and second-order perspectives to enhance its scientific validity and predictive power. The analysis confirms the validity of the proposed ITU-compliant methods and emphasizes the critical role of the human visual system's architecture, particularly the specialization of the magnocellular (M) and parvocellular (P) pathways, as the foundational justification for foveated quality assessment. Recommendations are made to move beyond simple opinion scores by using JND staircases to establish precise, quantifiable performance thresholds. The report also advocates for the use of eye-tracking data to derive objective, gaze-contingent metrics and for the application of advanced statistical techniques like non-parametric effect sizes and equivalence tests to ensure the robustness and nuanced interpretation of the findings. The integration of these principles will transform the study from a simple preference test into a powerful diagnostic tool for codec optimization and a definitive demonstration of Biomimeta's perceptual superiority.

2. The Neurobiological Basis of Perceptual Video Quality

2.1. The Human Visual System as a Smart Filter Bank

The human visual system (HVS) is a sophisticated, multi-stage processing system, not a passive image capture device. Its architecture is optimized for extracting and prioritizing information from a continuous stream of visual data, a fact that explains why traditional, pixel-based objective metrics such as PSNR often fail to correlate with human perception of quality. The HVS acts as a non-linear, adaptive filter bank, and a video codec designed to be perceptually superior must be one that effectively manipulates this biological system without introducing noticeable degradations. This section details the hierarchical neurobiological structures that are most relevant to the proposed PQS, from retinal pathways to cortical processing, thereby providing a robust theoretical foundation for the study's design.

2.2. The Magnocellular (M) and Parvocellular (P) Pathways

The retina's output is segregated into two primary parallel streams: the M (magnocellular) and P (parvocellular) pathways. The functional properties of these pathways are distinct and directly relate to the types of video artifacts that viewers find most objectionable.
The M-pathway is characterized by large cell bodies, large receptive fields, and thick axons with fast conduction velocities. M-cells exhibit a transient response to stimuli and are highly sensitive to low spatial and high temporal frequencies. This specialization makes the M-pathway the primary system for motion detection and depth perception. Artifacts such as motion blur, temporal instability, and jerkiness are primarily processed by this pathway. Conversely, the P-pathway consists of smaller cells, smaller receptive fields, and axons with slower conduction velocities. P-cells respond in a sustained manner and are sensitive to high spatial frequencies and color information, making them critical for the perception of fine details and form. Consequently, artifacts like blocking, ringing, and the loss of fine texture are predominantly perceived through the P-pathway. A PQS that measures only a single, aggregated mean opinion score (MOS) may obscure distinct performance profiles of a codec. For instance, a codec might excel at compressing high-motion scenes by intelligently handling M-pathway signals, but perform poorly on high-detail static scenes, thereby failing to satisfy the P-pathway's demands. The research explicitly defines the M-pathway's role in processing high temporal frequency information (motion) and the P-pathway's role in high spatial frequency information (fine detail). Therefore, a comprehensive PQS must incorporate video content designed to systematically challenge both pathways. For example, the UVG dataset includes sequences like "Jockey" and "ReadySetGo," which are characterized by high motion and would be ideal for evaluating M-pathway performance, while scenes with fine textures or still, detailed objects would be better suited for assessing P-pathway processing.

2.3. The Cortical Receptive Field and the Foveal Advantage

The user's proposal to focus on foveated or attention-weighted regions is a direct consequence of the HVS's cortical architecture. Information from the retina is first sent to the LGN and then projects to the primary visual cortex (V1). In V1, a significant transformation occurs. While LGN neurons have circularly symmetric, concentric receptive fields, V1 neurons are exquisitely tuned for specific orientations and motion directions. This specialization enables the perception of edges and contours, which are the fundamental building blocks of objects and visual scenes. The classic feed-forward model, proposed by Hubel and Wiesel, suggests that V1 simple cells are formed by the linear summation of inputs from multiple LGN cells with receptive fields that

are aligned along a specific axis.
A key organizational principle of V1 is its "retinotopic map," where neighboring points in the visual field are represented by neighboring neurons in the cortex. However, this map is not uniform; it is characterized by a high degree of cortical magnification in the fovea, the central region of the visual field where visual acuity is highest. This neurobiological reality provides the fundamental justification for foveated rendering and compression techniques. Artifacts such as blocking and ringing are essentially false edges or high-frequency noise. V1 simple cells, with their orientation tuning, are perfectly equipped to detect these kinds of degradations. Therefore, the study's artifact tagging measure should be explicitly designed to correlate with these neurophysiological principles, turning the PQS into a rigorous validation of the codec's neurobiologically-informed design. The study could leverage existing datasets and research, such as the Allen Brain Observatory Visual Coding dataset, which contains recordings of neural activity in V1 in response to specific stimuli like oriented drifting gratings, to provide a basis for designing stimuli and interpreting results.

2.4. The Contrast Sensitivity Function (CSF) as a Foundational Metric

The Contrast Sensitivity Function (CSF) is considered the gold standard for measuring spatial vision. It quantifies the lowest contrast level at which a viewer can detect a stimulus of a given spatial frequency. The CSF of a typical human observer with normal vision has a characteristic band-pass shape, with peak sensitivity occurring at approximately 4 cycles per degree (cpd). Sensitivity drops off at both lower and higher spatial frequencies, with an upper limit of around 60 cpd. The CSF is a dynamic measure that is influenced by various factors, including background luminance, age, and neurological conditions such as multiple sclerosis and glaucoma. This function essentially provides a quantitative map of the HVS's limits.
Video compression artifacts often manifest as degradations in specific spatial frequency bands. For instance, "ringing" artifacts around an edge are a form of high-frequency distortion, while "blocking" artifacts can be seen as mid-to-low frequency noise. By understanding the HVS's sensitivity across the spatial frequency spectrum, the PQS can move beyond using arbitrary video content and instead use carefully selected stimuli that probe specific points on the CSF curve. The study could use video content with fine, high-contrast textures to assess performance in high spatial frequencies (P-pathway domain) and content with smooth gradients to evaluate performance at lower frequencies (M-pathway domain). This systematic, purpose-driven approach to content selection ensures that the study's results are not just content-dependent observations, but are generalizable and predictive of the codec's performance across the entire spectrum of human vision. The PQS plan should therefore be refined to explicitly link the types of artifacts tagged by human observers to the specific regions of the CSF that the codec is designed to optimize.

Table 1: Key Properties of the Magnocellular (M) and Parvocellular (P) Visual Pathways

Pathway	Primary Function	Receptive Field Size	Response Type	Preferred Frequencies	Associated Artifacts
Magnocellular (M)	Motion, Depth Perception	Large	Transient	Low Spatial, High Temporal	Motion blur, temporal instability, jerkiness
Parvocellular (P)	Form, Fine Detail, Color	Small	Sustained	High Spatial, Low Temporal	Blocking, ringing,

Pathway	Primary Function	Receptive Field Size	Response Type	Preferred Frequencies	Associated Artifacts
					fine-detail loss, color banding

3. Critical Review of the Proposed Perceptual Quality Studies (PQS)

3.1. Psychophysical Methodologies: A Hierarchy of Precision

The PQS proposal correctly identifies a suite of gold-standard psychophysical methodologies compliant with ITU-T P.910 and ITU-R BT.500 recommendations. The use of multiple methods is a strength, as each offers a different level of precision and insight.

- **Absolute Category Rating (ACR) / MOS:** This single-stimulus method is a foundational tool for subjective quality assessment. Viewers rate a video on a five-point scale, from "Bad" to "Excellent," which are then mapped to a numerical scale from 1 to 5 to produce a Mean Opinion Score (MOS). ACR is effective for gathering a high-level, general sense of quality for a large number of video sequences. However, it is susceptible to individual bias and differences in how observers interpret the verbal labels.
- **Double-Stimulus Impairment Scale (DSIS):** The DSIS method is a more focused technique that minimizes content-dependent biases. In this test, an observer first views an unimpaired reference video, followed by an impaired version. They then rate the impairment of the second video on a five-point scale, which ranges from "Imperceptible" to "Very Annoying". This method is particularly valuable for diagnosing and quantifying the perceived severity of specific artifacts.
- **Paired Comparison & JND Staircases:** Paired comparison is a robust, forced-choice method that minimizes bias by asking observers to choose which of two video clips has higher quality. This approach does not require observers to agree on the meaning of a numerical or verbal scale. The Just-Noticeable-Difference (JND) staircase is an adaptive version of the paired comparison task that is highly efficient for determining perceptual thresholds. By progressively increasing or decreasing the quality of one video relative to another, the method reliably converges on the point of subjective equality (PSE), providing a quantitative measure of the threshold at which an artifact becomes detectable. The staircase procedure is considered more efficient and less susceptible to starting conditions than the method of constant stimuli.

A tiered approach to the PQS would be highly effective. The initial stages could use ACR to screen a broad range of content-bitrate pairs, followed by a more detailed DSIS study on the most relevant pairs to tag specific artifacts. The JND staircase could then be used on a subset of critical content to establish a precise, quantifiable performance threshold. This would allow the study to move beyond a simple "Biomimeta is better" claim to a more powerful, evidence-based statement: "Viewers can detect a difference between Biomimeta and AV1 only when the quality gap exceeds X JNDs, which corresponds to a bitrate difference of Y%."

3.2. Measures and Metrics: Bridging Subjective and Objective Data

The PQS proposal correctly identifies a number of measures and metrics, including the use of eye-tracking. An in-depth analysis of these measures reveals a path toward a more sophisticated and diagnostic study.

- **Objective and Subjective Metrics:** Objective metrics like VMAF, PSNR, and SSIM are valuable for rapid, automated evaluation, but they are not always a perfect proxy for human perception. VMAF, for example, is a machine learning-based metric that has been shown to correlate better with subjective scores than PSNR or SSIM but can still be vulnerable to adversarial attacks that manipulate scores without improving visual quality. The primary role of the PQS is to generate high-quality subjective data that can be used as ground truth to train or validate these objective metrics for a specific codec. The Bjontegaard Delta (BD-Rate) method is the standard for reporting the final results of the study, as it provides a single, summary value (e.g., a percentage) for the average bitrate savings of one codec over another for the same perceptual quality.

- **The Power of Eye-Tracking:** The inclusion of eye-tracking is a crucial differentiator for this PQS. Eye-tracking technology provides objective data on the inherently subjective process of viewing and can be used to generate novel, gaze-contingent quality metrics. Simple heatmaps are a good starting point for visualizing areas of attention, but a more advanced analysis can be performed using metrics like Average Eye Gaze Containment (AEGC) and Average Perceptual Resolution Gain (APRG). For a foveated codec, the AEGC measures the percentage of gaze samples that fall within the high-quality region of interest (ROI). This provides a direct, quantitative measure of the study's central hypothesis: that the codec maintains quality in the areas that matter most. The APRG is another valuable metric that estimates the bandwidth or computational savings achieved by the foveated approach, with a value greater than one indicating a benefit. The PQS should collect eye-tracking data not just to visualize attention but to calculate and report on these specific metrics, thereby providing powerful, quantitative evidence to support the qualitative findings from the subjective ratings.

3.3. Leveraging Visual Phenomena: Saccadic Suppression

Saccadic suppression is a key neurobiological phenomenon that can be leveraged to design a more efficient and perceptually robust codec. Saccades are rapid eye movements that occur roughly three times per second. To prevent the perception of motion blur during these movements, the HVS actively reduces visual sensitivity by 3-10 fold just before, during, and after a saccade. This active suppression, which is thought to be mediated by pathways involving the LGN and superior colliculus, begins approximately 50-75 ms before the saccade onset. The effect is particularly strong for low spatial frequencies, which would otherwise be perceived as motion smear. A codec that is aware of this phenomenon could strategically reduce the bitrate in peripheral regions during a saccade, confident that the resulting artifacts would be imperceptible to the viewer. This would be a form of "neurobiological cheating" that could yield significant bitrate savings without any perceived loss of quality. The PQS should not only use eye-tracking to weight visual quality but also to test this hypothesis directly. The study could include a condition where the Biomimeta codec is configured to exploit saccadic suppression, and the eye-tracking data could be analyzed to confirm that no increase in artifacts is reported by participants during these periods. This would demonstrate a deeper, more nuanced understanding of the HVS and provide a competitive advantage.

Table 2: Comparison of Perceptual Study Methodologies

Method	Stimulus Presentation	Key Advantage	Key Disadvantage	Best Use Case
ACR (MOS)	Single Video	Fast, broad screening	Susceptible to scale bias	High-level quality screening

Method	Stimulus Presentation	Key Advantage	Key Disadvantage	Best Use Case
DCR/DSIS	Reference vs. Impaired	Diagnoses specific artifacts	Requires unimpaired reference	Diagnostic artifact analysis
Paired Comparison	A vs. B	Minimizes observer bias	Time-consuming	Direct performance comparison
JND Staircase	Adaptive Reference	Efficiently finds thresholds	Focused on a single threshold	Quantifying perceptual limits

4. Advanced Statistical Analysis and Interpretation

4.1. The Power of Mixed-Effects Models

The proposed PQS uses a within-subjects design, where each participant rates all video conditions. This is a powerful and efficient design, but it requires statistical methods that can account for the correlation between data points from the same individual. Standard statistical tests, such as t-tests or simple ANOVA, assume independence and would be inappropriate for this type of data. The PQS plan correctly identifies the use of repeated-measures ANOVA or, more flexibly, mixed-effects models as the appropriate statistical tools.
A mixed-effects model can be used to disentangle the main effects of codec, bitrate, and content type on perceptual quality while accounting for the random effects of individual participants. This level of sophistication allows the analysis to move beyond a simple comparison of overall average scores to a diagnostic understanding of performance. For example, a mixed-effects model could reveal a significant "codec × content" interaction, indicating that Biomimeta's performance gain is significantly larger for high-motion content than for static content. This provides a more granular and actionable understanding of where the codec excels, which is invaluable for both engineering and marketing purposes. The report should emphasize that this level of statistical analysis is critical for producing robust, defensible findings and for avoiding the misleading conclusions that can arise from analyzing aggregated data.

4.2. Beyond Significance: The Importance of Effect Size and Equivalence

The PQS proposal is forward-thinking in its inclusion of effect size measures and equivalence testing.

- **Effect Size:** Reporting a p-value only indicates whether a difference is statistically significant; it does not convey the magnitude or practical importance of that difference. Effect size measures, such as Cohen's d, provide this context. However, Cohen's d assumes a normal distribution, which may not be the case for subjective ratings on a five-point scale. Cliff's delta is a non-parametric alternative that is more robust to non-normal data and unequal variances. It measures the probability that a randomly selected score from one group is higher than a score from another, providing a more reliable and informative measure of group difference for this type of data. The PQS should report both measures to provide a comprehensive view of the results.
- **Equivalence Tests (TOST):** A traditional null-hypothesis significance test (e.g., a t-test) can only show that two codecs are statistically different. A failure to reject the null

hypothesis is not a formal proof that they are the same. Equivalence testing, specifically the Two One-Sided t-test (TOST), is a formal statistical method for demonstrating that the difference between two means lies within a predefined, acceptable equivalence limit. This is a critical tool for a codec comparison study. For example, if Biomimeta and AV1 achieve the same MOS score at a specific bitrate, a TOST test can be used to formally state that the perceptual quality of the two codecs is equivalent, a much stronger and more useful conclusion than simply stating that no significant difference was found.

4.3. Ensuring Reliability: The Role of Cronbach's Alpha

Before any inferential statistics are run on the subjective ratings, the reliability of the data itself must be established. Cronbach's alpha is the appropriate statistical measure for assessing the internal consistency of the ratings across observers. It measures the extent to which a set of ratings are consistently measuring the same underlying concept (in this case, video quality). A Cronbach's alpha value greater than 0.7 is generally considered acceptable, and a value over 0.95 may indicate redundancy in the items. A high Cronbach's alpha is a key quality control metric that confirms the collective judgment of the observer panel is trustworthy and not just a collection of random opinions. The PQS should include the calculation of Cronbach's alpha as a standard part of its quality control process.

Table 3: Statistical Analysis Plan for the Biomimeta PQS

Analysis Step	Metric(s) Used	Hypothesis Tested	Interpretation
Quality Control	Cronbach's α	Are observer ratings reliable and consistent?	A high alpha value confirms the integrity of the subjective data.
Main Effects	Repeated-measures ANOVA / Mixed-effects models	Are there significant main effects of codec, bitrate, and content?	A significant p-value indicates that a factor had a measurable impact on quality.
Pairwise Comparisons	Cliff's delta, Cohen's d	What is the magnitude of the preference for one codec over another?	Report effect size to demonstrate practical significance.
Equivalence Testing	Two One-Sided t-test (TOST)	Are the codecs perceptually equivalent at a given quality level?	A successful TOST test provides a formal proof of equivalence within a specified margin.

5. Implementation Details and Ethical Considerations

5.1. Test Material Selection and Pre-processing

The selection of test content is a critical and often-overlooked component of a robust PQS. The UVG dataset is an excellent choice for this study, as it consists of 16 versatile 4K video sequences captured at 50 or 120 fps. This dataset's content varies in its spatial and temporal complexity, which is essential for a comprehensive evaluation of a codec. Sequences like "Jockey," "ReadySetGo," and "ShakeNDry" are high-motion, dynamic scenes ideal for testing the M-pathway, while "Beauty" and "CityAlley" contain fine details and would be better for assessing P-pathway performance. Using a publicly available and non-commercial dataset like

UVG ensures the study's results are reproducible and comparable with other published work. The report should recommend pre-categorizing the selected content based on its spatial and temporal characteristics. This allows for a more granular analysis, such as comparing the performance of Biomimeta and AV1 specifically on high-motion content, which can reveal valuable diagnostic information about the codec's strengths and weaknesses.

5.2. Controlled Environment vs. Remote Testing

The PQS proposes both a controlled lab test and a short-form remote variant. A controlled lab environment, following ITU-R BT.500 recommendations, is crucial for obtaining gold-standard, high-fidelity data. A controlled environment minimizes confounding variables by standardizing display calibration (e.g., D65 white point, specific gamma and luminance settings), viewing distance, and ambient lighting. Remote testing, while cost-effective and scalable, is inherently less reliable due to the lack of control over these factors. However, a moderated remote test can serve a valuable, complementary role. A two-phase approach is recommended: Phase 1 would be the core lab study with a smaller group of 24 to 36 highly screened participants to generate the primary, high-confidence results. Phase 2 would be a larger, short-form remote study with a larger participant pool to demonstrate the codec's performance in a variety of real-world, uncontrolled environments. The remote test should include rigorous quality checks and be moderated to mitigate the inherent unreliability of a distributed study.

5.3. Ethical Considerations: The Foundation of Trust

Ethical research requires informed consent, a debriefing of participants, and strict data privacy protocols. The PQS must address the unique ethical challenges posed by collecting video and eye-tracking data. These data streams can contain highly personal information, including a person's gaze patterns, interests, and emotional responses. Furthermore, video of a person's face (for QC checks or from eye-tracking cameras) is personally identifiable. The following recommendations should be strictly followed:

1. **Informed Consent:** The consent form must explicitly state what data will be collected (e.g., ratings, eye-tracking, demographics), how it will be used (e.g., for research, not for individual tracking), and how it will be protected.
2. **Anonymization:** All data must be anonymized at the earliest possible stage by replacing personal identifiers with a unique subject ID.
3. **Data Storage:** All raw video and eye-tracking footage must be stored securely, with limited access granted only to essential research personnel.
4. **Data Retention:** A clear policy for the retention and eventual destruction of all sensitive data must be established and communicated to participants. This comprehensive approach to ethics is essential for building trust with participants and ensuring the integrity of the research.

6. Recommendations and Conclusion

The PQS for the Biomimeta codec is a well-designed study with the potential to yield groundbreaking results. The following recommendations are provided to maximize its scientific rigor and commercial impact:

1. **Refine the Test Stimuli:** Systematically select video content from the UVG dataset and other sources to specifically challenge both the M-pathway (high motion) and P-pathway

(fine detail), in addition to a general set of videos. This will provide a more granular and diagnostic understanding of the codec's performance profile.

2. **Employ JND Staircases:** Prioritize JND staircase procedures for a subset of the most critical content-bitrate pairs. This will allow the study to move beyond general preference and establish a precise, quantifiable threshold of perceptual quality, which is more valuable for engineering and product development.
3. **Leverage Eye-Tracking:** Use eye-tracking data to derive quantitative, gaze-contingent metrics such as Average Eye Gaze Containment (AEGC) and Average Perceptual Resolution Gain (APRG) to objectively validate the benefits of foveated rendering.
4. **Incorporate Saccadic Suppression:** Design a test condition to evaluate the hypothesis that the codec can strategically reduce bitrate during saccades without a perceived loss of quality. This would be a powerful demonstration of a neurobiologically-inspired design.
5. **Use Robust Statistics:** Employ mixed-effects models to correctly analyze the within-subjects data. Use both Cohen's d and the more robust Cliff's delta to report effect sizes. Finally, use the Two One-Sided t-test (TOST) to formally prove perceptual equivalence where appropriate.

By incorporating these refinements, the PQS for the Biomimeta codec will not only demonstrate its superiority but also provide a new standard for how video quality is assessed, bridging the gap between engineering and the fundamental principles of human vision. This approach will position the Biomimeta codec as a truly innovative solution, with a performance profile that is not only measurably better but also scientifically justified.

Works cited

1. www.fastpix.io, https://www.fastpix.io/blog/understanding-vmaf-psnr-and-ssim-full-reference-video-quality-metrics#:~:text=PSNR%20is%20useful%20for%20quick,accuracy%20and%20human%20visual%20experience. 2. Parallel Streams of Information from Retina to Cortex - Neuroscience - NCBI Bookshelf, https://www.ncbi.nlm.nih.gov/books/NBK10922/ 3. Visual Processing: Cortical Pathways (Section 2, Chapter 15) Neuroscience Online - Department of Neurobiology & Anatomy, https://nba.uth.tmc.edu/neuroscience/m/s2/chapter15.html 4. m&p_reading - UMSL, https://umsl.edu/~garziar/m&p_reading.htm 5. Neural mechanisms mediating motion sensitivity in parasol ganglion cells of the primate retina - PMC - PubMed Central, https://pmc.ncbi.nlm.nih.gov/articles/PMC5866240/ 6. Efficient Coding by Midget and Parasol Ganglion Cells in the Human Retina - PMC, https://pmc.ncbi.nlm.nih.gov/articles/PMC7442669/ 7. Orientation Sensitivity of Ganglion Cells in Primate Retina - PMC - PubMed Central, https://pmc.ncbi.nlm.nih.gov/articles/PMC6880403/ 8. UVG Dataset - Ultra Video Group, https://ultravideo.fi/dataset.html 9. Perception Lecture Notes: LGN and V1, https://www.cns.nyu.edu/~david/courses/perception/lecturenotes/V1/lgn-V1.html 10. Lateral geniculate nucleus - Wikipedia, https://en.wikipedia.org/wiki/Lateral_geniculate_nucleus 11. Neural Mechanisms of Orientation Selectivity in the Visual Cortex - Columbia University, http://www.columbia.edu/cu/neurotheory/Ken/pubs/fm_final.pdf 12. NEURAL MECHANISMS OF ORIENTATION SELECTIVITY IN THE VISUAL CORTEX - Center for Theoretical Neuroscience, https://ctn.zuckermaninstitute.columbia.edu/sites/default/files/content/PDFs%20Miller/neural%20mechanisms.pdf 13. THE FEEDFORWARD MODEL, http://www.columbia.edu/cu/neurotheory/Ken/fm_final/node3.html 14. The visual CSF characteristic curve. The CSF curve is divided into five... | Download Scientific Diagram - ResearchGate,

https://www.researchgate.net/figure/The-visual-CSF-characteristic-curve-The-CSF-curve-is-divided-into-five-segments-which_fig3_322610115 15. Learning receptive field properties of complex cells in V1 | PLOS Computational Biology, https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1007957 16. A CORF computational model of a simple cell that relies on LGN input outperforms the Gabor function model - ResearchGate, https://www.researchgate.net/publication/224819376_A_CORF_computational_model_of_a_simple_cell_that_relies_on_LGN_input_outperforms_the_Gabor_function_model 17. Natural Stimulus Statistics Alter the Receptive Field Structure of V1 Neurons - PMC, https://pmc.ncbi.nlm.nih.gov/articles/PMC6729594/ 18. Orientation Selectivity in Macaque V1: Diversity and Laminar Dependence - PMC, https://pmc.ncbi.nlm.nih.gov/articles/PMC6758222/ 19. Mapping spatial frequency preferences across human primary visual cortex | JOV, https://jov.arvojournals.org/article.aspx?articleid=2778653 20. Orientation tuning bandwidth. A, Bandwidths (half-width at half ..., https://www.researchgate.net/figure/Orientation-tuning-bandwidth-A-Bandwidths-half-width-at-half-height-of-K-o-cells_fig5_236225023 21. Modeling neural contrast sensitivity functions in human visual cortex - MIT Press Direct, https://direct.mit.edu/imag/article/doi/10.1162/imag_a_00469/127702/Modeling-neural-contrast-sensitivity-functions-in 22. Contrast (vision) - Wikipedia, https://en.wikipedia.org/wiki/Contrast_(vision) 23. Contrast Sensitivity Function (CSF): - Stereo Optical, https://www.stereooptical.com/wp-content/uploads/2022/03/Contrast-Sensitivity-Function-White-Paper-10-2021.pdf 24. Spatial Contrast Sensitivity | Metropsis, https://www.psychophysics.uk/spatial-contrast-sensitivity/ 25. Spatio-chromatic contrast sensitivity under mesopic and photopic light levels | JOV, https://jov.arvojournals.org/article.aspx?articleid=2765519 26. Modeling neural contrast sensitivity functions in human visual cortex - PMC, https://pmc.ncbi.nlm.nih.gov/articles/PMC12319964/ 27. P.910 (10/2023) - ITU-T Recommendation database, https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=15697&lang=en 28. Comparing Subjective Video Quality Testing Methodologies, https://its.ntia.gov/publications/download/spie03subj.pdf 29. Perceptual Video Quality Assessment Tool - DiVA portal, https://www.diva-portal.org/smash/get/diva2:829860/FULLTEXT01.pdf 30. Absolute Category Rating - Wikipedia, https://en.wikipedia.org/wiki/Absolute_Category_Rating 31. Subjective video quality - Wikipedia, https://en.wikipedia.org/wiki/Subjective_video_quality 32. Subjective Video Quality Assessment Methods for Multimedia Applications - ResearchGate, https://www.researchgate.net/publication/263434394_Subjective_Video_Quality_Assessment_Methods_for_Multimedia_Applications 33. Adaptive Paired-Comparison Method for Subjective Video ... - arXiv, https://arxiv.org/pdf/1807.02175 34. Video Quality Metrics | Cloudinary, https://cloudinary.com/glossary/video-quality-metrics 35. In-place Double Stimulus Methodology for Subjective Assessment of High Quality Images, https://arxiv.org/html/2508.09777v1 36. Tutorial 2: Measuring a JND using a staircase procedure — PsychoPy v2025.2.1, https://www.psychopy.org/coder/tutorial2.html 37. Staircase procedure and constant stimuli method in cat psychophysics - PubMed, https://pubmed.ncbi.nlm.nih.gov/2285478/ 38. Video Multimethod Assessment Fusion - Wikipedia, https://en.wikipedia.org/wiki/Video_Multimethod_Assessment_Fusion 39. Toward a Better Quality Metric for the Video Community | by Netflix Technology Blog, https://netflixtechblog.com/toward-a-better-quality-metric-for-the-video-community-7ed94e752a30 40. Stable VMAF: investigating VMAF's vulnerabilities to adversarial attacks - ResearchGate, https://www.researchgate.net/publication/391327776_Stable_VMAF_investigating_VMAF's_vulnerabilities_to_adversarial_attacks 41. Bjontegaard Delta-Rate Metric. ABSTRACT: This article provides an… | by Maxim Sharabayko, PhD | Innovation Labs Blog | Medium, https://medium.com/innovation-labs-blog/bjontegaard-delta-rate-metric-c8c82c1bc42c 42. Bjøntegaard Delta (BD): A Tutorial Overview of the Metric, Evolution, Challenges, and Recommendations - ResearchGate, https://www.researchgate.net/publication/377296684_Bjontegaard_Delta_BD_A_Tutorial_Overview_of_the_Metric_Evolution_Challenges_and_Recommendations 43. Computation of BD-Rate. Dmin and Dmax indicate the range of integration... - ResearchGate, https://www.researchgate.net/figure/Computation-of-BD-Rate-Dmin-and-Dmax-indicate-the-range-of-integration-along-distortion_fig3_377296684 44. Eye Tracking - iMotions, https://imotions.com/eye-tracking/ 45. Online Eye Tracking | Webcam eye-tracking software, https://gazerecorder.com/ 46. Gaze-Contingent Video Compression with Targeted Gaze ..., https://userweb.cs.txstate.edu/~ok11/papers_published/2009_JEI_Ko.pdf 47. Cortical Contributions to Saccadic Suppression - Research journals, https://journals.plos.org/plosone/article/file?type=printable&id=10.1371/journal.pone.0006900 48. Saccade suppression of displacements, but not of contrast, depends on context | JOV, https://jov.arvojournals.org/article.aspx?articleid=2783634 49. Visual sensitivity of frontal eye field neurons during the preparation ..., https://pmc.ncbi.nlm.nih.gov/articles/PMC5174155/ 50. Within Subjects Designs - YouTube, https://www.youtube.com/watch?v=1I26sNUhiiw 51. Introduction to linear mixed models - What's new Amidst Science?, https://gkhajduk.github.io/2017-03-09-mixed-models/ 52. Multilevel Mixed-Effects Modeling Using MATLAB - MathWorks, https://www.mathworks.com/videos/multilevel-mixed-effects-modeling-using-matlab-91755.html 53. Robust effect sizes for 2 independent groups - basic statistics - WordPress.com, https://garstats.wordpress.com/2016/05/02/robust-effect-sizes-for-2-independent-groups/ 54. Using Cliff's Delta as a Non-Parametric Effect Size Measure: An ..., https://www.researchgate.net/publication/377696423_Using_Cliff's_Delta_as_a_Non-Parametric_Effect_Size_Measure_An_Accessible_Web_App_and_R_Tutorial 55. Struggling to Run a Two One-Sided Equivalence Test (TOST)? - QI Macros for Excel, https://www.qimacros.com/hypothesis-testing/equivalence-test/ 56. Statistical Equivalence Testing for Assessing Bench-Scale Cleanability, https://www.biopharminternational.com/view/statistical-equivalence-testing-assessing-bench-scale-cleanability 57. Cronbach's alpha - Reliability analysis (update) 3 - YouTube, https://www.youtube.com/watch?v=mOrxoeRIrkc 58. Using and Interpreting Cronbach's Alpha | UVA Library, https://library.virginia.edu/data/articles/using-and-interpreting-cronbachs-alpha 59. Understanding how to calibrate your monitor | Adobe, https://www.adobe.com/creativecloud/video/discover/how-to-calibrate-monitor.html 60. (PDF) Subjective quality assessment of an adaptive video streaming model - ResearchGate, https://www.researchgate.net/publication/263660723_Subjective_quality_assessment_of_an_adaptive_video_streaming_model 61. A Survey on QoE-Oriented VR Video Streaming: Some Research Issues and Challenges, https://www.mdpi.com/2079-9292/10/17/2155 62. Is it ethically acceptable to publish video clips and images without the consent of a 'difficult to reach' participant? | ResearchGate, https://www.researchgate.net/post/Is_it_ethically_acceptable_to_publish_video_clips_and_images_without_the_consent_of_a_difficult_to_reach_participant 63. Privacy and Confidentiality |

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https://atlasti.com/guides/qualitative-research-guide-part-1/confidentiality-privacy-research