Impact of Feedback on Crowdsourced Visual Quality Assessment with Paired Comparisons

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June 18, 2024

Background

- **Crowdsourcing for image and video quality assessent**
- **Advantages of Crowdsourcing:**
  - Easy access to diverse populations
  - Scalability for large experiments
  - Time-efficient and cost-effective
- **Challenges in Crowdsourcing:**
  - Maintaining attention of crowdworkers
  - Ensuring high-quality, accurate data

Motivation

- **Need for Reliable Crowdsourcing Tasks:**
  - Ensure high-quality data collection from crowdworkers
  - Improve the efficiency and reliability of subjective image quality assessments
- **Immediate Feedback as Simple Gamification element:**
  - Provide real-time feedback on accuracy of the crowdworkers' responses
  - Increase engagement and motivation of crowdworkers

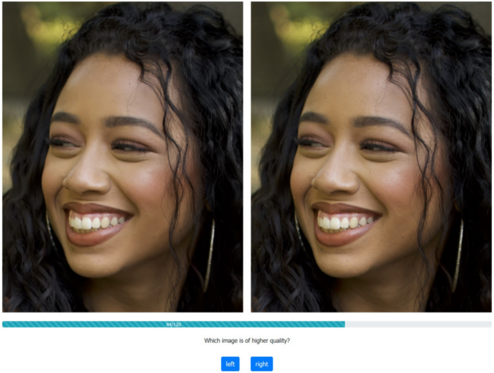
Hypotheses

Task: Just noticeable difference (JND) based image quality assessment

- **Hypothesis 1:** Feedback does not influence the JND estimation
- **Hypothesis 2:** Feedback increases the precision of JND assessment

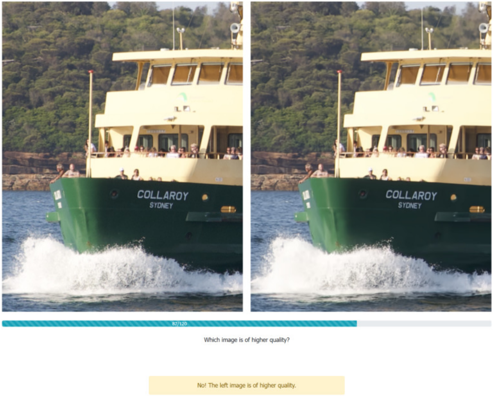
Experimental Setup

- With-in subject design experiment
- Test conditions:
  - 2AFC with feedback (AFCF)
  - 2AFC without feedback (AFCN)
- Order of conditions randomized for each subject
- Feedback provided in the form of text and audible beeps
- A cognitive load questionnaire followed the PCs for each condition.



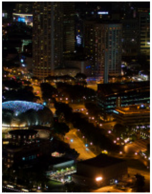
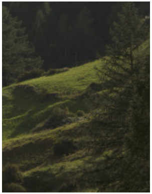
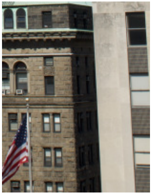
Feedback for correct response
Text message + low frequency audible beep

Feedback for wrong response
Text message + high frequency audible beep



Source and test images

- We used 5 source images from JPEG AIC dataset
- Compressed by two codecs, VVC Intra and JPEG XL at 10 distortion levels
- 5(sources) $\times$ 2(codecs) $\times$ 10(dist. levels) $=$ 100 PCs (questions)
- 20 trap questions (with strong distortion difference)
- 6 training questions

Crowdsourcing

- Conducted on Amazon Mechanical Turk (MTurk).
- Each worker completed 120 paired comparisons with and without feedback.
- Order of the questions are randomized for each participant
- Involved 200 crowdworkers (the responses of 149 workers accepted)

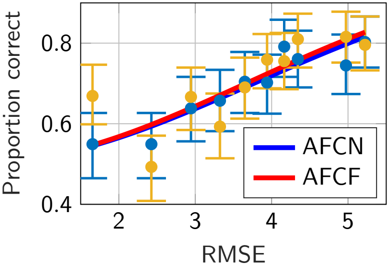
Statistical model for data analysis

- Weibull psychometric function (PSF) is fitted to the proportions of correct responses.

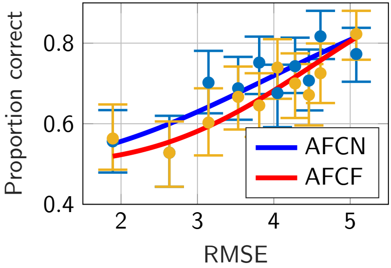
$$\psi(x;\lambda,k) = \frac{1}{2} + \frac{1}{2}\left(1 - e^{-(x/\lambda)^k}\right)$$

  - x: Independent variable (RMSE in a compressed image).
  - λ: Scale parameter.
  - k: Shape parameter.
  - JND reported at 75% proportion correct $\psi(x;\lambda,k) = 0.75$

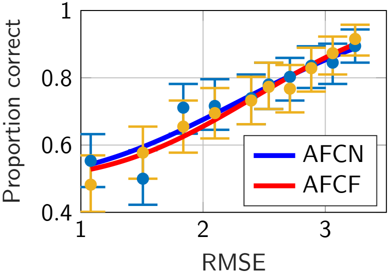
Results: Fitted PSF



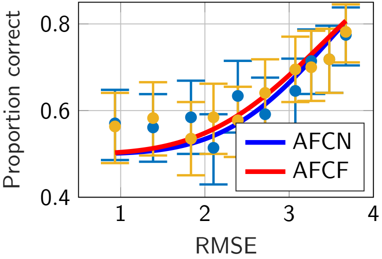
(a) S6-JPEG XL



(b) S10-JPEG XL



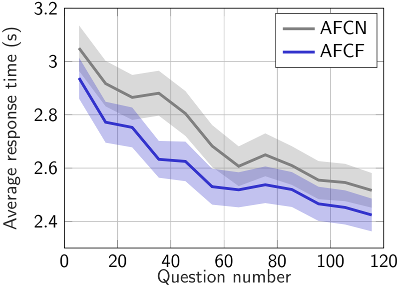
(c) S6-VVC



(d) S10-VVC

Results: Response time

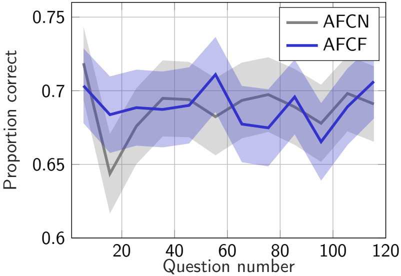
- **Average response time:**
  - With feedback (AFCF): 2.598 seconds
  - Without feedback (AFCN): 2.723 seconds
- **Significance:**
  - P-value: 0.0005
  - Feedback significantly reduced response time ("small" effect size, Cohen's d = 0.1).



Effect size	**Cohen's d**
small	0.20
medium	0.50
large	0.80
Very large	1.20

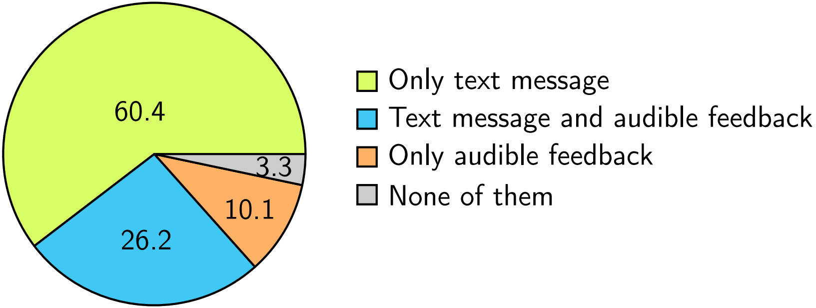
Results: Learning effect

- **Proportion of correct responses over time:**
  - No significant learning effect observed.
  - No significant difference between conditions with and without feedback.
- **Batch 2 Analysis:**
  - Lower proportion of correct responses.
  - Two-proportion Z-test: Z-score = 0.45, p-value = 0.65.



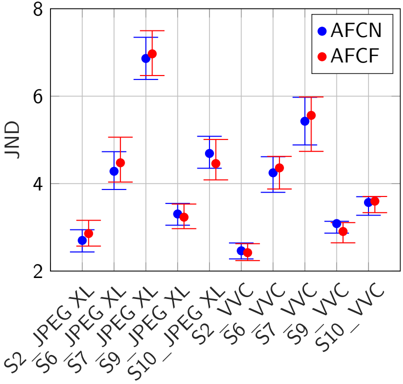
Results: User experience

- **Questionnaire analysis:**
  - Wilcoxon matched-pairs signed ranks test.
  - Significant difference in confidence sub-scale ($p < 0.05$).
  - Higher confidence without feedback.
  - No significant difference in other 6 subscales and overall.
- **Feedback Preference:**
  - 97% preferred receiving feedback.



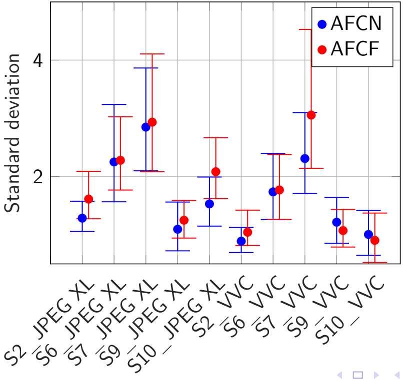
Results: Assessment of JND

- **H1**: Feedback does not influence the JND estimation.
- **Findings:**
  - No significant difference in JND estimation between feedback (AFCF) and no feedback (AFCN) conditions.
- **Conclusion:** H1 is not rejected.



Results:Precision of JND assessment

- **H2:** Feedback increases the precision of JND assessment.
- **Findings:**
  - Standard deviation of Weibull distributions used to measure precision.
  - Overlapping confidence intervals indicate no significant difference in precision between conditions.
- **Conclusion:** H2 is rejected.



Conclusion

Feedback impact:

- No bias in JND estimation.
- No significant effect on accuracy.
- No significant learning effect observed.
- Reduced response times.
- Almost all crowdworkers preferred receiving feedback.

Future works:

- Incorporating more gamification elements:
  - Leaderboards with ranking and scores
  - Progress bars
  - Competitive features

Access the dataset and subjective data here: