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# Look, Listen, and Answer: Overcoming Biases for Audio-Visual Question Answering

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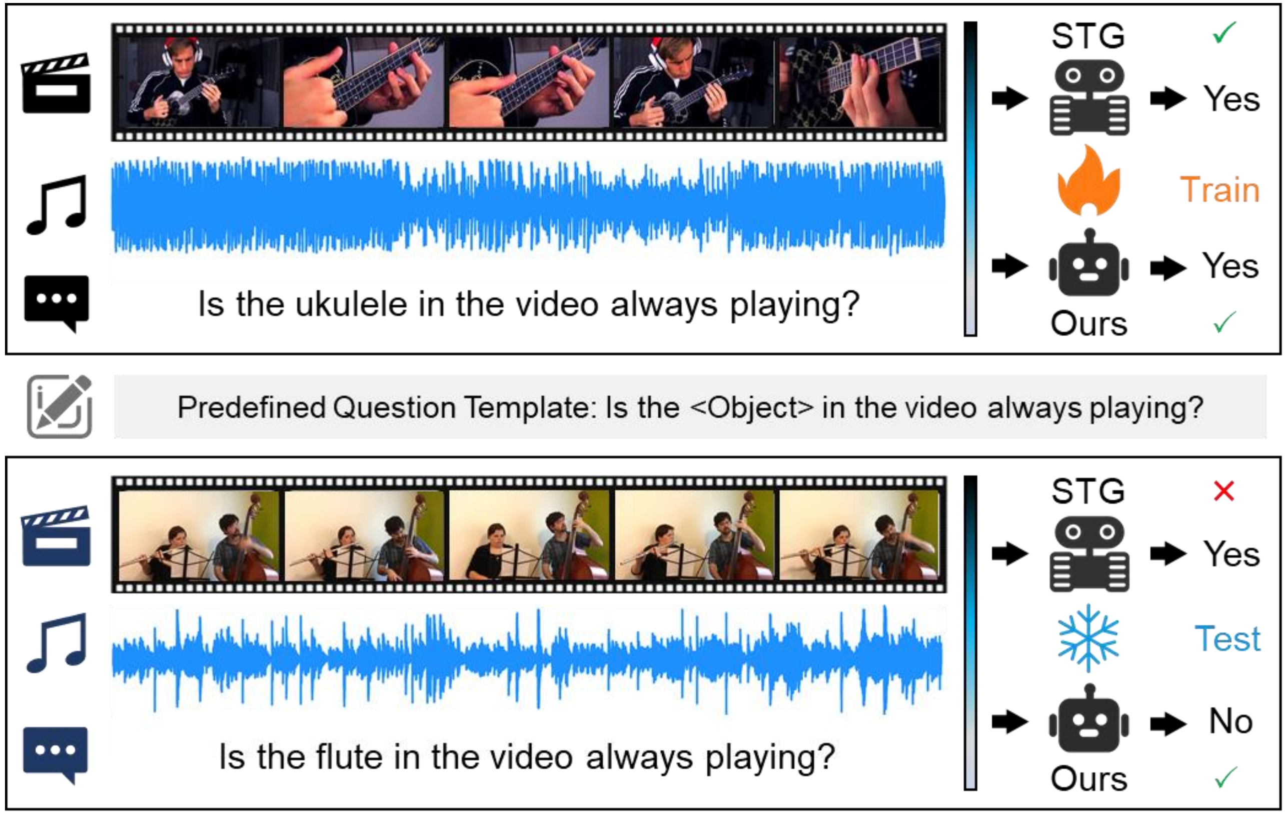
# Motivation

- Audio-Visual Question Answering (AVQA) is a complex multi-modal reasoning task, demanding intelligent systems to accurately respond to natural language queries based on audio-video input pairs.



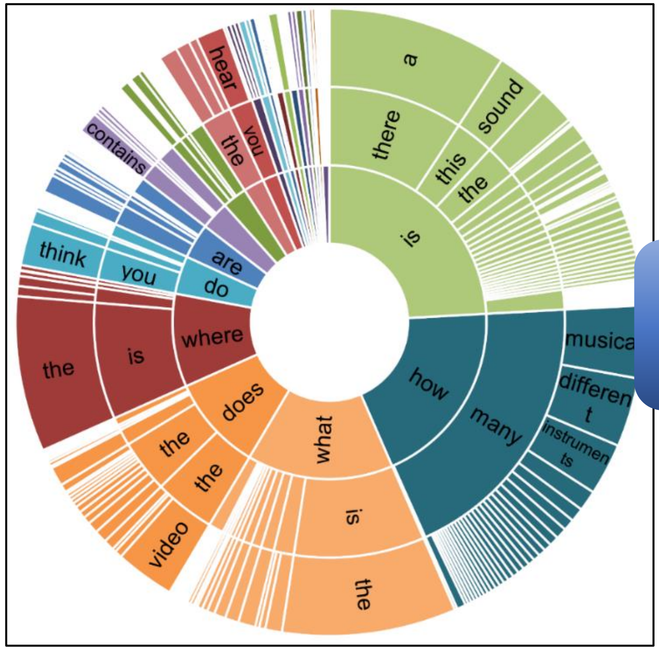
STG
✓
Yes
Train
Yes
Ours
✓
Is the ukulele in the video always playing?
Predefined Question Template: Is the <Object> in the video always playing?
STG
✗
Yes
Test
No
Ours
✓
Is the flute in the video always playing?

**Question 1:** have existing datasets comprehensively measured model robustness?

**Question 2:** have existing methods overcome the data bias?

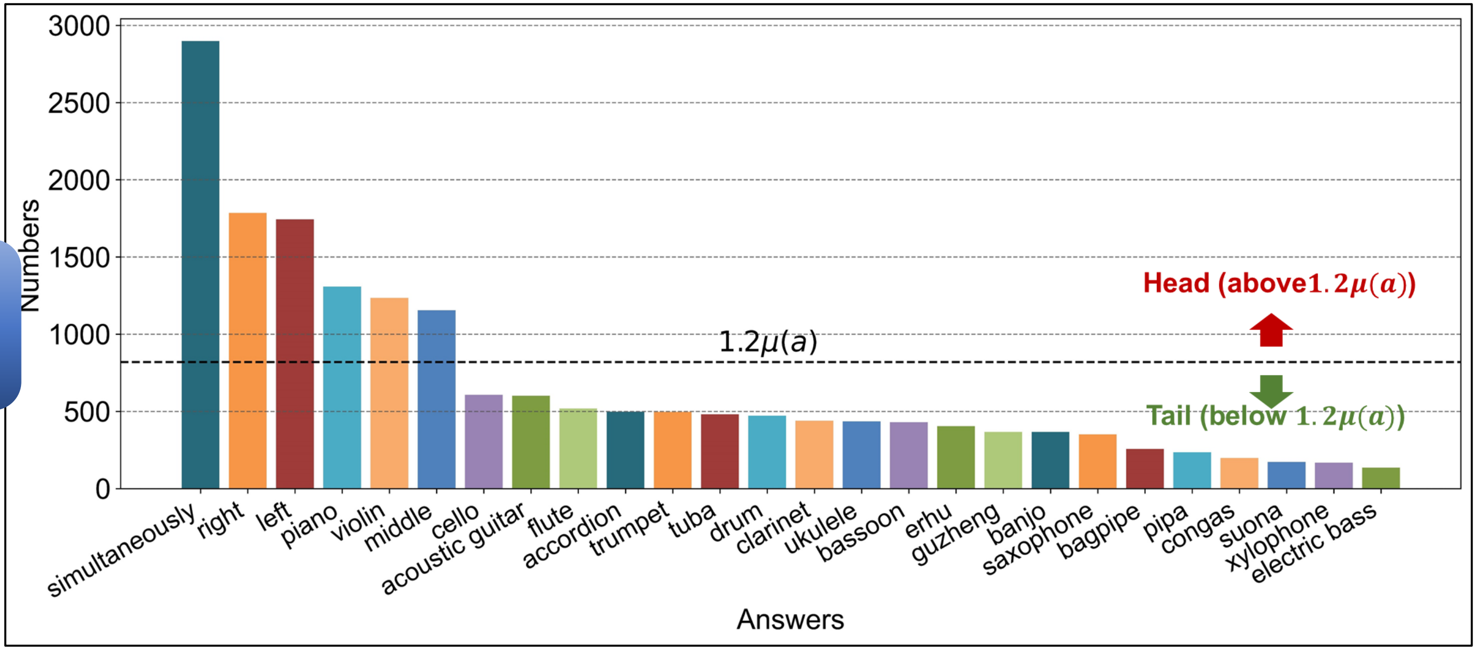
# Dataset Development and Analysis

- The construction of this dataset involves two key processes: rephrasing and splitting.



Distribution of rephrasing questions based on the first three words.

MUSIC-AVQA-R

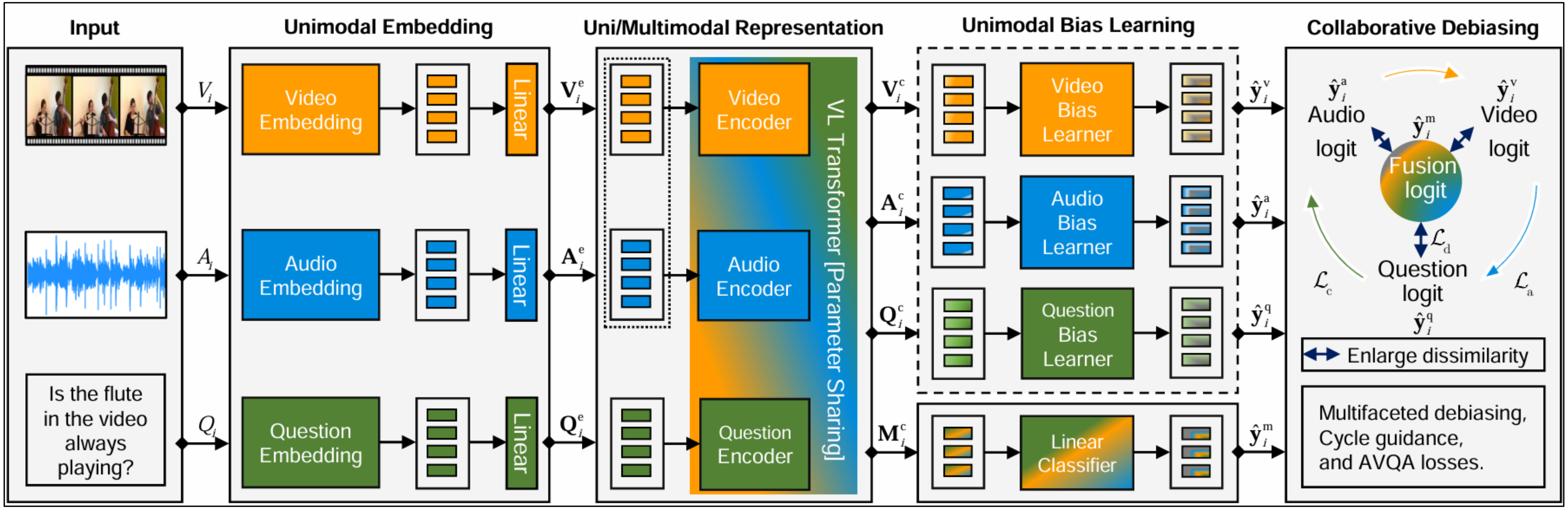


Answer distributions of “Temporal” questions in the AVQA task.

- The former involves the rephrasing of questions in the test split of MUSIC-AVQA, and the latter is dedicated to the categorization of questions into frequent (head) and rare (tail) subsets.

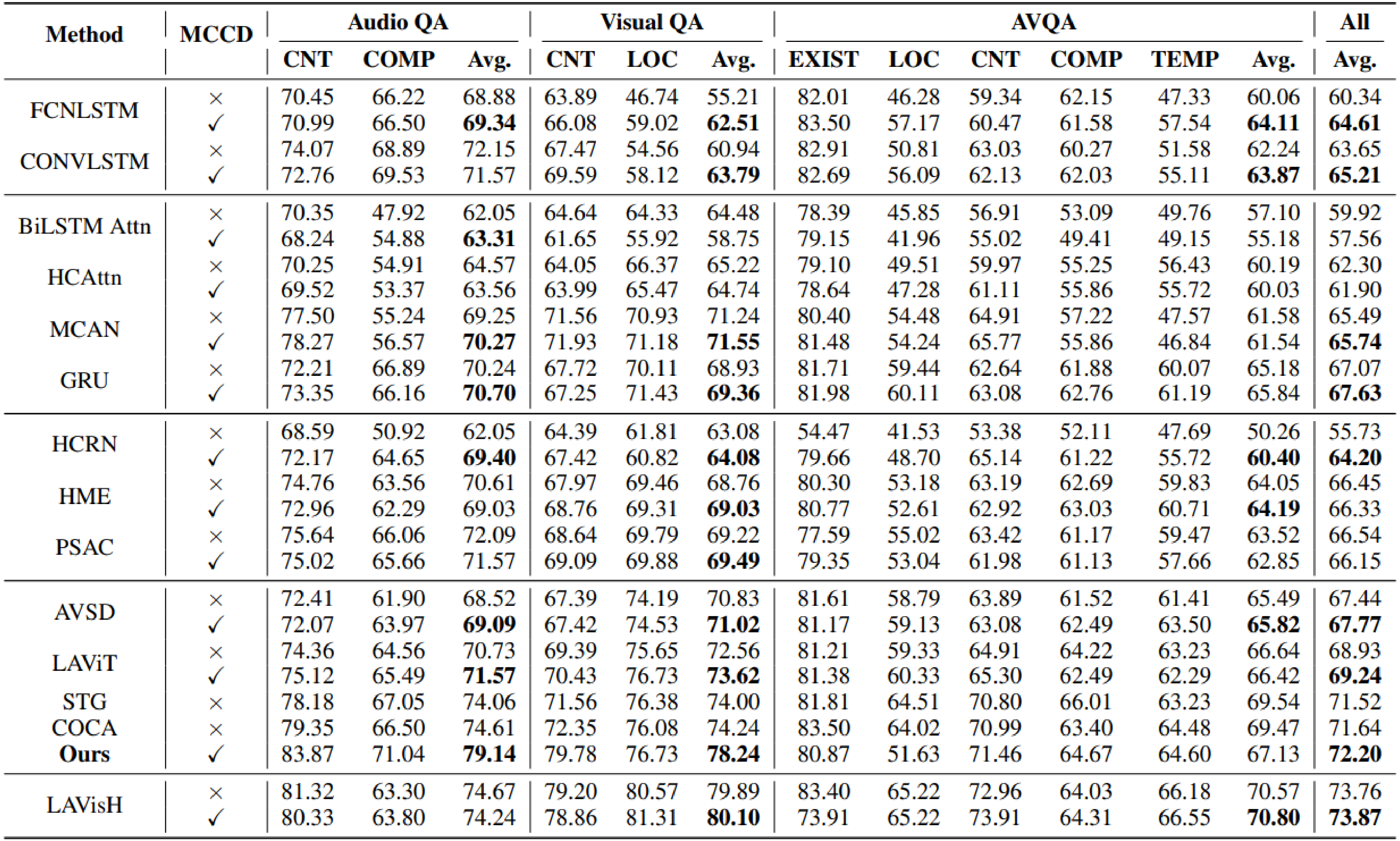
# Method

- **Architecture of multifaceted cycle collaborative debiasing**



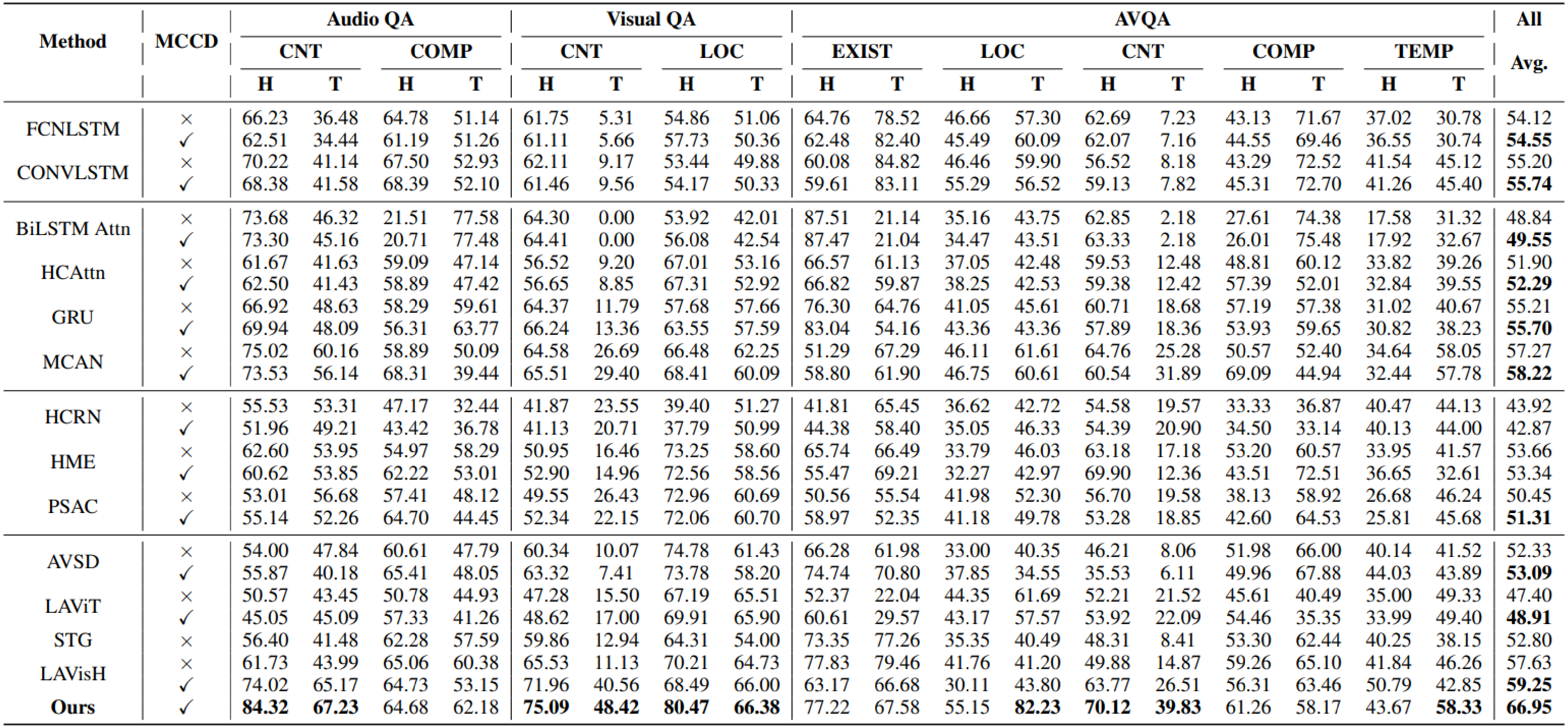
$$\mathcal{L}_d = \frac{\alpha}{3K}\sum_{i=1}^{K}\left(\frac{1}{d_i^a}+\frac{1}{d_i^v}+\frac{1}{d_i^q}\right), \qquad \mathcal{L}_c = \frac{\beta}{3}\left(\mathcal{L}_{qa}+\mathcal{L}_{av}+\mathcal{L}_{vq}\right), \qquad \mathcal{L}_{qa} = \frac{1}{K}\sum_{i=1}^{K}\hat{y}_i^q\left(log\hat{y}_i^q - log\hat{y}_i^a\right), \qquad \mathcal{L} = \mathcal{L}_d + \mathcal{L}_c + \mathcal{L}_a$$

# Main Results on the MUSIC-AVQA Dataset



| Method | MCCD | Audio QA | | | Visual QA | | | AVQA | | | | | | All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CNT | COMP | Avg. | CNT | LOC | Avg. | EXIST | LOC | CNT | COMP | TEMP | Avg. | Avg. |
| FCNLSTM | × | 70.45 | 66.22 | 68.88 | 63.89 | 46.74 | 55.21 | 82.01 | 46.28 | 59.34 | 62.15 | 47.33 | 60.06 | 60.34 |
| | ✓ | 70.99 | 66.50 | **69.34** | 66.08 | 59.02 | **62.51** | 83.50 | 57.17 | 60.47 | 61.58 | 57.54 | **64.11** | **64.61** |
| CONVLSTM | × | 74.07 | 68.89 | 72.15 | 67.47 | 54.56 | 60.94 | 82.91 | 50.81 | 63.03 | 60.27 | 51.58 | 62.24 | 63.65 |
| | ✓ | 72.76 | 69.53 | 71.57 | 69.59 | 58.12 | **63.79** | 82.69 | 56.09 | 62.13 | 62.03 | 55.11 | **63.87** | **65.21** |
| BiLSTM Attn | × | 70.35 | 47.92 | 62.05 | 64.64 | 64.33 | 64.48 | 78.39 | 45.85 | 56.91 | 53.09 | 49.76 | 57.10 | 59.92 |
| | ✓ | 68.24 | 54.88 | **63.31** | 61.65 | 55.92 | 58.75 | 79.15 | 41.96 | 55.02 | 49.41 | 49.15 | 55.18 | 57.56 |
| HCAttn | × | 70.25 | 54.91 | 64.57 | 64.05 | 66.37 | 65.22 | 79.10 | 49.51 | 59.97 | 55.25 | 56.43 | 60.19 | 62.30 |
| | ✓ | 69.52 | 53.37 | 63.56 | 63.99 | 65.47 | 64.74 | 78.64 | 47.28 | 61.11 | 55.86 | 55.72 | 60.03 | 61.90 |
| MCAN | × | 77.50 | 55.24 | 69.25 | 71.56 | 70.93 | 71.24 | 80.40 | 54.48 | 64.91 | 57.22 | 47.57 | 61.58 | 65.49 |
| | ✓ | 78.27 | 56.57 | **70.27** | 71.93 | 71.18 | **71.55** | 81.48 | 54.24 | 65.77 | 55.86 | 46.84 | 61.54 | **65.74** |
| GRU | × | 72.21 | 66.89 | 70.24 | 67.72 | 70.11 | 68.93 | 81.71 | 59.44 | 62.64 | 61.88 | 60.07 | 65.18 | 67.07 |
| | ✓ | 73.35 | 66.16 | **70.70** | 67.25 | 71.43 | **69.36** | 81.98 | 60.11 | 63.08 | 62.76 | 61.19 | 65.84 | **67.63** |
| HCRN | × | 68.59 | 50.92 | 62.05 | 64.39 | 61.81 | 63.08 | 54.47 | 41.53 | 53.38 | 52.11 | 47.69 | 50.26 | 55.73 |
| | ✓ | 72.17 | 64.65 | **69.40** | 67.42 | 60.82 | **64.08** | 79.66 | 48.70 | 65.14 | 61.22 | 55.72 | **60.40** | **64.20** |
| HME | × | 74.76 | 63.56 | 70.61 | 67.97 | 69.46 | 68.76 | 80.30 | 53.18 | 63.19 | 62.69 | 59.83 | 64.05 | 66.45 |
| | ✓ | 72.96 | 62.29 | 69.03 | 68.76 | 69.31 | **69.03** | 80.77 | 52.61 | 62.92 | 63.03 | 60.71 | **64.19** | 66.33 |
| PSAC | × | 75.64 | 66.06 | 72.09 | 68.64 | 69.79 | 69.22 | 77.59 | 55.02 | 63.42 | 61.17 | 59.47 | 63.52 | 66.54 |
| | ✓ | 75.02 | 65.66 | 71.57 | 69.09 | 69.88 | **69.49** | 79.35 | 53.04 | 61.98 | 61.13 | 57.66 | 62.85 | 66.15 |
| AVSD | × | 72.41 | 61.90 | 68.52 | 67.39 | 74.19 | 70.83 | 81.61 | 58.79 | 63.89 | 61.52 | 61.41 | 65.49 | 67.44 |
| | ✓ | 72.07 | 63.97 | **69.09** | 67.42 | 74.53 | **71.02** | 81.17 | 59.13 | 63.08 | 62.49 | 63.50 | **65.82** | **67.77** |
| LAViT | × | 74.36 | 64.56 | 70.73 | 69.39 | 75.65 | 72.56 | 81.21 | 59.33 | 64.91 | 64.22 | 63.23 | 66.64 | 68.93 |
| | ✓ | 75.12 | 65.49 | **71.57** | 70.43 | 76.73 | **73.62** | 81.38 | 60.33 | 65.30 | 62.49 | 62.29 | 66.42 | **69.24** |
| STG | × | 78.18 | 67.05 | 74.06 | 71.56 | 76.38 | 74.00 | 81.81 | 64.51 | 70.80 | 66.01 | 63.23 | 69.54 | 71.52 |
| COCA | × | 79.35 | 66.50 | 74.61 | 72.35 | 76.08 | 74.24 | 83.50 | 64.02 | 70.99 | 63.40 | 64.48 | 69.47 | 71.64 |
| **Ours** | ✓ | 83.87 | 71.04 | **79.14** | 79.78 | 76.73 | **78.24** | 80.87 | 51.63 | 71.46 | 64.67 | 64.60 | 67.13 | **72.20** |
| LAVisH | × | 81.32 | 63.30 | 74.67 | 79.20 | 80.57 | 79.89 | 83.40 | 65.22 | 72.96 | 64.03 | 66.18 | 70.57 | 73.76 |
| | ✓ | 80.33 | 63.80 | 74.24 | 78.86 | 81.31 | **80.10** | 73.91 | 65.22 | 73.91 | 64.31 | 66.55 | **70.80** | **73.87** |

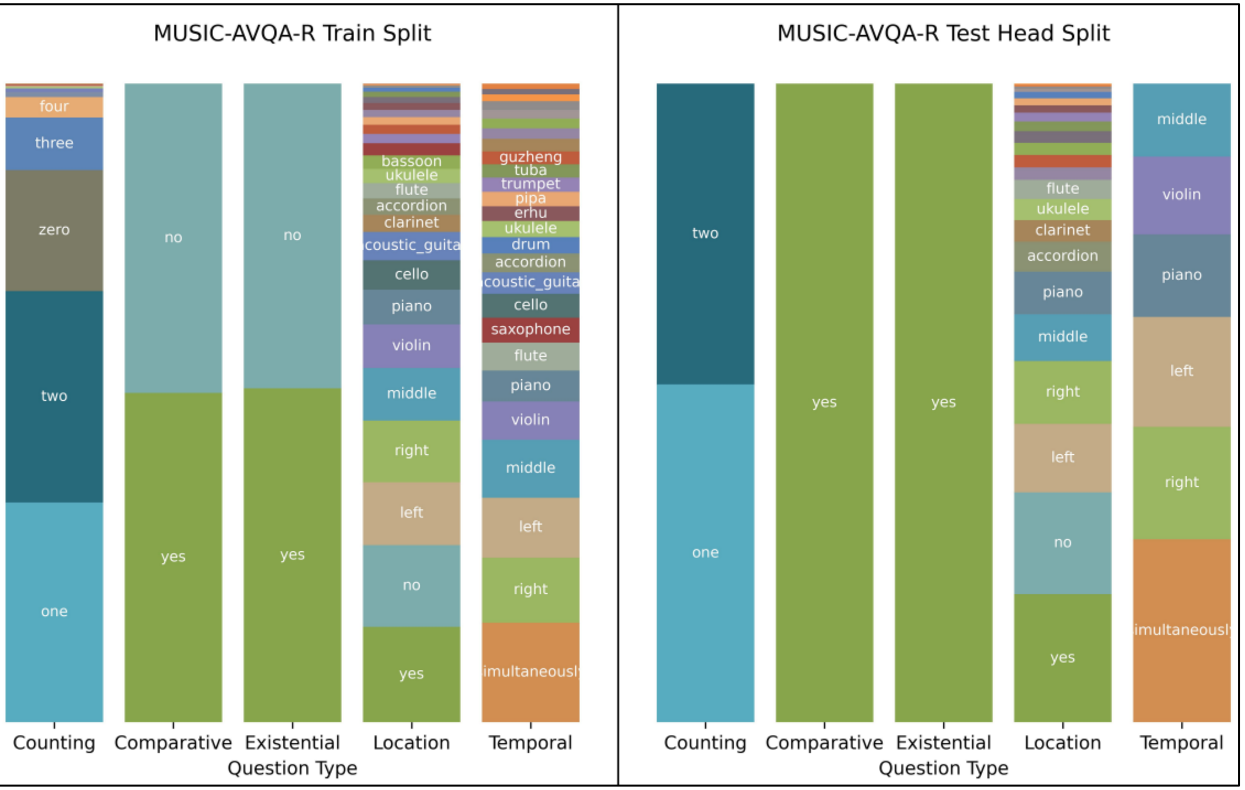
# Main Results on the MUSIC-AVQA-R Dataset

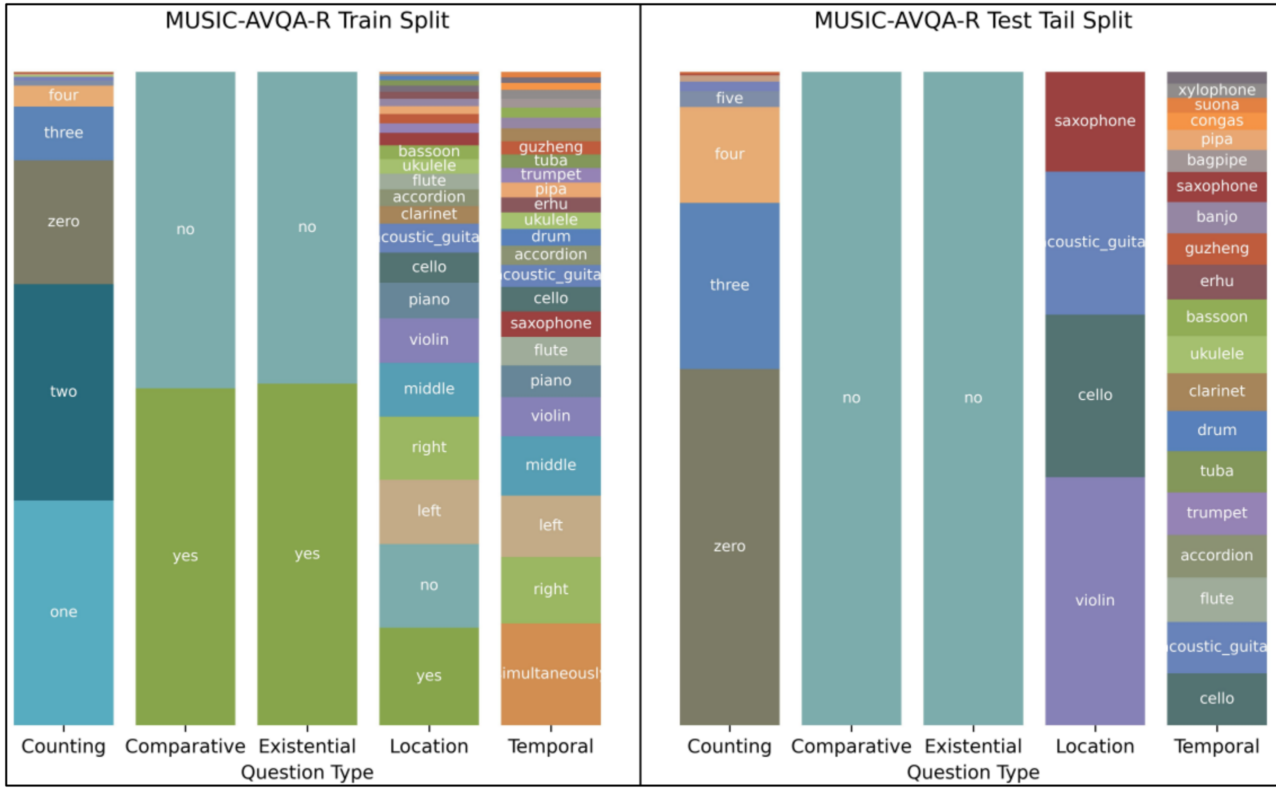


| Method | MCCD | Audio QA | | | | Visual QA | | | | AVQA | | | | | | | | | | All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CNT | | COMP | | CNT | | LOC | | EXIST | | LOC | | CNT | | COMP | | TEMP | | Avg. |
| | | H | T | H | T | H | T | H | T | H | T | H | T | H | T | H | T | H | T | |
| FCNLSTM | × | 66.23 | 36.48 | 64.78 | 51.14 | 61.75 | 5.31 | 54.86 | 51.06 | 64.76 | 78.52 | 46.66 | 57.30 | 62.69 | 7.23 | 43.13 | 71.67 | 37.02 | 30.78 | 54.12 |
| | ✓ | 62.51 | 34.44 | 61.19 | 51.26 | 61.11 | 5.66 | 57.73 | 50.36 | 62.48 | 82.40 | 45.49 | 60.09 | 62.07 | 7.16 | 44.55 | 69.46 | 36.55 | 30.74 | **54.55** |
| CONVLSTM | × | 70.22 | 41.14 | 67.50 | 52.93 | 62.11 | 9.17 | 53.44 | 49.88 | 60.08 | 84.82 | 46.46 | 59.90 | 56.52 | 8.18 | 43.29 | 72.52 | 41.54 | 45.12 | 55.20 |
| | ✓ | 68.38 | 41.58 | 68.39 | 52.10 | 61.46 | 9.56 | 54.17 | 50.33 | 59.61 | 83.11 | 55.29 | 56.52 | 59.13 | 7.82 | 45.31 | 72.70 | 41.26 | 45.40 | **55.74** |
| BiLSTM Attn | × | 73.68 | 46.32 | 21.51 | 77.58 | 64.30 | 0.00 | 53.92 | 42.01 | 87.51 | 21.14 | 35.16 | 43.75 | 62.85 | 2.18 | 27.61 | 74.38 | 17.58 | 31.32 | 48.84 |
| | ✓ | 73.30 | 45.16 | 20.71 | 77.48 | 64.41 | 0.00 | 56.08 | 42.54 | 87.47 | 21.04 | 34.47 | 43.51 | 63.33 | 2.18 | 26.01 | 75.48 | 17.92 | 32.67 | **49.55** |
| HCAttn | × | 61.67 | 41.63 | 59.09 | 47.14 | 56.52 | 9.20 | 67.01 | 53.16 | 66.57 | 61.13 | 37.05 | 42.48 | 59.53 | 12.48 | 48.81 | 60.12 | 33.82 | 39.26 | 51.90 |
| | ✓ | 62.50 | 41.43 | 58.89 | 47.42 | 56.65 | 8.85 | 67.31 | 52.92 | 66.82 | 59.87 | 38.25 | 42.53 | 59.38 | 12.42 | 57.39 | 52.01 | 32.84 | 39.55 | **52.29** |
| GRU | × | 66.92 | 48.63 | 58.29 | 59.61 | 64.37 | 11.79 | 57.68 | 57.66 | 76.30 | 64.76 | 41.05 | 45.61 | 60.71 | 18.68 | 57.19 | 57.38 | 31.02 | 40.67 | 55.21 |
| | ✓ | 69.94 | 48.09 | 56.31 | 63.77 | 66.24 | 13.36 | 63.55 | 57.59 | 83.04 | 54.16 | 43.36 | 43.36 | 57.89 | 18.36 | 53.93 | 59.65 | 30.82 | 38.23 | **55.70** |
| MCAN | × | 75.02 | 60.16 | 58.89 | 50.09 | 64.58 | 26.69 | 66.48 | 62.25 | 51.29 | 67.29 | 46.11 | 61.61 | 64.76 | 25.28 | 50.57 | 52.40 | 34.64 | 58.05 | 57.27 |
| | ✓ | 73.53 | 56.14 | 68.31 | 39.44 | 65.51 | 29.40 | 68.41 | 60.09 | 58.80 | 61.90 | 46.75 | 60.61 | 60.54 | 31.89 | 69.09 | 44.94 | 32.44 | 57.78 | **58.22** |
| HCRN | × | 55.53 | 53.31 | 47.17 | 32.44 | 41.87 | 23.55 | 39.40 | 51.27 | 41.81 | 65.45 | 36.62 | 42.72 | 54.58 | 19.57 | 33.33 | 36.87 | 40.47 | 44.13 | 43.92 |
| | ✓ | 51.96 | 49.21 | 43.42 | 36.78 | 41.13 | 20.71 | 37.79 | 50.99 | 44.38 | 58.40 | 35.05 | 46.33 | 54.39 | 20.90 | 34.50 | 33.14 | 40.13 | 44.00 | 42.87 |
| HME | × | 62.60 | 53.95 | 54.97 | 58.29 | 50.95 | 16.46 | 73.25 | 58.60 | 65.74 | 66.49 | 33.79 | 46.03 | 63.18 | 17.18 | 53.20 | 60.57 | 33.95 | 41.57 | 53.66 |
| | ✓ | 60.62 | 53.85 | 62.22 | 53.01 | 52.90 | 14.96 | 72.56 | 58.56 | 55.47 | 69.21 | 32.27 | 42.97 | 69.90 | 12.36 | 43.51 | 72.51 | 36.65 | 32.61 | 53.34 |
| PSAC | × | 53.01 | 56.68 | 57.41 | 48.12 | 49.55 | 26.43 | 72.96 | 60.69 | 50.56 | 55.54 | 41.98 | 52.30 | 56.70 | 19.58 | 38.13 | 58.92 | 26.68 | 46.24 | 50.45 |
| | ✓ | 55.14 | 52.26 | 64.70 | 44.45 | 52.34 | 22.15 | 72.06 | 60.70 | 58.97 | 52.35 | 41.18 | 49.78 | 53.28 | 18.85 | 42.60 | 64.53 | 25.81 | 45.68 | **51.31** |
| AVSD | × | 54.00 | 47.84 | 60.61 | 47.79 | 60.34 | 10.07 | 74.78 | 61.43 | 66.28 | 61.98 | 33.00 | 40.35 | 46.21 | 8.06 | 51.98 | 66.00 | 40.14 | 41.52 | 52.33 |
| | ✓ | 55.87 | 40.18 | 65.41 | 48.05 | 63.32 | 7.41 | 73.78 | 58.20 | 74.74 | 70.80 | 37.85 | 34.55 | 35.53 | 6.11 | 49.96 | 67.88 | 44.03 | 43.89 | **53.09** |
| LAViT | × | 50.57 | 43.45 | 50.78 | 44.93 | 47.28 | 15.50 | 67.19 | 65.51 | 52.37 | 22.04 | 44.35 | 61.69 | 52.21 | 21.52 | 45.61 | 40.49 | 35.00 | 49.33 | 47.40 |
| | ✓ | 45.05 | 45.09 | 57.33 | 41.26 | 48.62 | 17.00 | 69.91 | 65.90 | 60.61 | 29.57 | 43.17 | 57.57 | 53.92 | 22.09 | 54.46 | 35.35 | 33.99 | 49.40 | **48.91** |
| STG | × | 56.40 | 41.48 | 62.28 | 57.59 | 59.86 | 12.94 | 64.31 | 54.00 | 73.35 | 77.26 | 35.35 | 40.49 | 48.31 | 8.41 | 53.30 | 62.44 | 40.25 | 38.15 | 52.80 |
| LAVisH | × | 61.73 | 43.99 | 65.06 | 60.38 | 65.53 | 11.13 | 70.21 | 64.73 | 77.83 | 79.46 | 41.76 | 41.20 | 49.88 | 14.87 | 59.26 | 65.10 | 41.84 | 46.26 | 57.63 |
| | ✓ | 74.02 | 65.17 | 64.73 | 53.15 | 71.96 | 40.56 | 68.49 | 66.00 | 63.17 | 66.68 | 30.11 | 43.80 | 63.77 | 26.51 | 56.31 | 63.46 | 50.79 | 42.85 | **59.25** |
| **Ours** | ✓ | **84.32** | **67.23** | 64.68 | 62.18 | **75.09** | **48.42** | **80.47** | **66.38** | 77.22 | 67.58 | 55.15 | **82.23** | **70.12** | **39.83** | 61.26 | 58.17 | 43.67 | **58.33** | **66.95** |

# Comparison in the MUSIC-AVQA-R dataset

- **Answer distribution between train and test split in the MUSIC-AVQA-R dataset.**





# Thanks