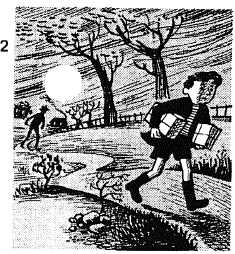
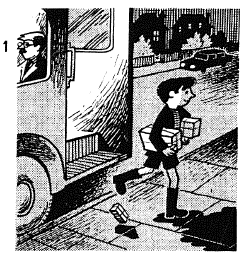
Appendix A. Training Materials and scripts of the model speech

“Chase”

1. John is a 10-year-old boy. Last week, he went shopping. It took him a long time to do his shopping and he caught a bus home late in the evening. It was dark when he got off the bus. He accidentally dropped a small box then.
2. John had to walk home through dark woods, and he felt a little frightened. Suddenly he heard a noise.
3. There was a strange man following John. John thought that the man would attack him.
4. John began to run home quickly, and the man also ran after him quickly. Then they crossed a bridge over the river.
5. He found his house a long way off. The next moment the man caught him and held his arm.
6. The man gave John the small box that John had dropped. He said that he followed John to give him the box. John was surprised but very glad. He thanked the man.



“Surprise”

1. Jack is a businessman. Three weeks ago, he arrived at an airport with a big basket. It was too heavy to carry, so he put it down. Two people were watching him from behind. One was a short boy with a striped shirt. The other was a tall man, and he wore sunglasses.
2. The short boy came close to Jack. When they started to talk, the tall man picked up the big basket.
3. When Jack realized that the two people were thieves and stole his basket, they ran away from the airport.
4. Jack hurried to a police officer and asked for help. The police officer tried to stop the thieves. He couldn’t stop them. The thieves got into a car and drove off.
5. The car passed a zoo and went into the woods.
6. When it reached the woods, it stopped, and the two people got out. They opened the basket that they had stolen and suddenly a snake appeared!

テキスト, 本, 地図 が含まれている画像

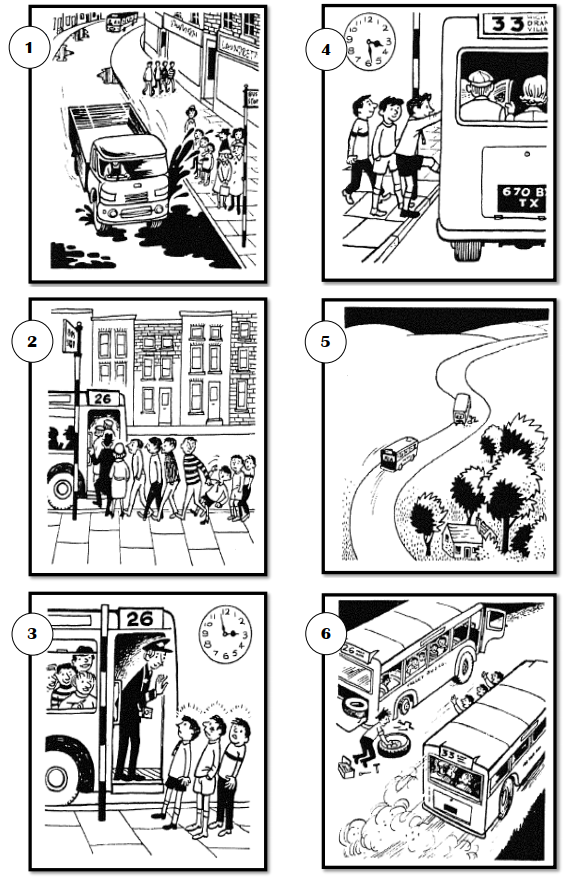
自動的に生成された説明

Appendix B. Test Material

“Bicycle” “Bus”

ダイアグラム, カレンダー

自動的に生成された説明



“Race”

ダイアグラム

自動的に生成された説明

Appendix C. Descriptive Statistics for Training Data

[Articulation Rate]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Massed Group | | | | |  | | Short-Spaced Group | | | | | |  | Long-spaced Group | | | | |
|  |  |  | 95% CI | | |  | |  | |  | | 95% CI | |  |  | | 95% CI | | |
|  | *M* | *SD* | | Lower | Upper | |  | *M* | *SD* | | Lower | | Upper |  | *M* | *SD* | | Lower | Upper | |
| Time 1 | 158.51 | 20.73 | | 148.81 | 168.21 | |  | 158.15 | 29.41 | | 145.43 | | 170.87 |  | 148.46 | 24.03 | | 137.52 | 159.40 | |
| Time 2 | 163.51 | 20.31 | | 154.38 | 172.64 | |  | 157.88 | 23.72 | | 148.19 | | 167.58 |  | 149.57 | 22.19 | | 140.07 | 159.06 | |
| Time 3 | 156.90 | 21.80 | | 147.10 | 166.71 | |  | 156.91 | 25.78 | | 146.38 | | 167.45 |  | 158.92 | 21.60 | | 149.69 | 168.16 | |
| Time 4 | 163.23 | 18.73 | | 154.81 | 171.65 | |  | 161.97 | 28.06 | | 150.51 | | 173.44 |  | 152.50 | 26.16 | | 141.31 | 163.69 | |
| Time 5 | 169.39 | 18.41 | | 161.11 | 177.67 | |  | 164.88 | 31.68 | | 151.93 | | 177.82 |  | 157.74 | 25.00 | | 147.05 | 168.43 | |
| Time 6 | 169.97 | 14.16 | | 163.60 | 176.34 | |  | 171.04 | 30.31 | | 158.65 | | 183.42 |  | 156.70 | 22.48 | | 147.09 | 166.31 | |
| One-week retention | 159.31 | 18.51 | | 150.98 | 167.63 | |  | 150.38 | 22.95 | | 141.00 | | 159.76 |  | 152.35 | 27.97 | | 140.39 | 164.31 | |

[Mid-Clause Pause Duration]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Massed Group | | | | |  | | Short-Spaced Group | | | | | |  | Long-spaced Group | | | | |
|  |  |  | 95% CI | | |  | |  | |  | | 95% CI | |  |  | | | 95% CI | |
|  | *M* | *SD* | | Lower | Upper | |  | *M* | *SD* | | Lower | | Upper |  | *M* | *SD* | Lower | | Upper | |
| Time 1 | 0.07 | 0.15 | | -0.002 | 0.14 | |  | 0.11 | 0.18 | | 0.04 | | 0.19 |  | 0.13 | 0.11 | 0.08 | | 0.18 | |
| Time 2 | 0.00 | 0.14 | | -0.06 | 0.06 | |  | 0.05 | 0.17 | | -0.02 | | 0.12 |  | 0.08 | 0.12 | 0.03 | | 0.13 | |
| Time 3 | -0.02 | 0.10 | | -0.06 | 0.02 | |  | 0.06 | 0.15 | | 0.00 | | 0.12 |  | 0.01 | 0.12 | -0.04 | | 0.06 | |
| Time 4 | -0.04 | 0.16 | | -0.11 | 0.03 | |  | -0.03 | 0.14 | | -0.09 | | 0.02 |  | 0.08 | 0.10 | 0.04 | | 0.13 | |
| Time 5 | -0.07 | 0.11 | | -0.12 | -0.02 | |  | -0.04 | 0.12 | | -0.09 | | 0.01 |  | 0.00 | 0.11 | -0.05 | | 0.04 | |
| Time 6 | -0.09 | 0.09 | | -0.13 | -0.05 | |  | -0.09 | 0.12 | | -0.14 | | -0.04 |  | -0.04 | 0.13 | -0.09 | | 0.02 | |
| One-week retention | -0.02 | 0.12 | | -0.08 | 0.03 | |  | 0.01 | 0.15 | | -0.06 | | 0.07 |  | 0.00 | 0.13 | -0.06 | | 0.05 | |

[Clause-Final Pause Duration]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Massed Group | | | | |  | | Short-Spaced Group | | | | | |  | Long-spaced Group | | | |
|  |  |  | 95% CI | | |  | |  | |  | | 95% CI | |  |  | | 95% CI | |
|  | *M* | *SD* | | Lower | Upper | |  | *M* | *SD* | | Lower | | Upper |  | *M* | *SD* | Lower | Upper | |
| Time 1 | 1.30 | 0.27 | | 1.17 | 1.43 | |  | 1.42 | 0.33 | | 1.28 | | 1.56 |  | 1.39 | 0.31 | 1.25 | 1.54 | |
| Time 2 | 1.29 | 0.34 | | 1.14 | 1.44 | |  | 1.47 | 0.28 | | 1.35 | | 1.58 |  | 1.40 | 0.30 | 1.28 | 1.53 | |
| Time 3 | 1.21 | 0.22 | | 1.11 | 1.31 | |  | 1.33 | 0.24 | | 1.23 | | 1.43 |  | 1.33 | 0.23 | 1.23 | 1.43 | |
| Time 4 | 1.17 | 0.20 | | 1.09 | 1.26 | |  | 1.27 | 0.26 | | 1.16 | | 1.37 |  | 1.45 | 0.30 | 1.32 | 1.59 | |
| Time 5 | 1.22 | 0.27 | | 1.10 | 1.34 | |  | 1.24 | 0.24 | | 1.14 | | 1.34 |  | 1.36 | 0.32 | 1.23 | 1.50 | |
| Time 6 | 1.13 | 0.20 | | 1.04 | 1.22 | |  | 1.23 | 0.25 | | 1.13 | | 1.33 |  | 1.28 | 0.23 | 1.18 | 1.38 | |
| One-week retention | 1.17 | 0.22 | | 1.07 | 1.27 | |  | 1.32 | 0.30 | | 1.19 | | 1.44 |  | 1.25 | 0.24 | 1.15 | 1.35 | |

[Mid-Clause Pause Frequency]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Massed Group | | | | |  | | Short-Spaced Group | | | | | |  | Long-spaced Group | | | | |
|  |  |  | 95% CI | | |  | |  | |  | | 95% CI | |  |  | | 95% CI | | |
|  | *M* | *SD* | | Lower | Upper | |  | *M* | *SD* | | Lower | | Upper |  | *M* | *SD* | | Lower | Upper | |
| Time 1 | 20.15 | 4.27 | | 18.16 | 22.15 | |  | 18.88 | 6.96 | | 15.87 | | 21.89 |  | 18.24 | 4.33 | | 16.27 | 20.21 | |
| Time 2 | 21.22 | 6.44 | | 18.33 | 24.12 | |  | 17.41 | 5.07 | | 15.34 | | 19.48 |  | 17.97 | 4.63 | | 15.99 | 19.95 | |
| Time 3 | 17.70 | 4.40 | | 15.72 | 19.67 | |  | 16.84 | 5.09 | | 14.76 | | 18.92 |  | 19.93 | 4.21 | | 18.13 | 21.73 | |
| Time 4 | 18.67 | 4.69 | | 16.56 | 20.78 | |  | 18.48 | 5.44 | | 16.25 | | 20.70 |  | 16.46 | 3.89 | | 14.80 | 18.12 | |
| Time 5 | 20.50 | 5.81 | | 17.89 | 23.12 | |  | 18.93 | 5.04 | | 16.87 | | 20.99 |  | 18.32 | 3.85 | | 16.67 | 19.97 | |
| Time 6 | 19.38 | 5.19 | | 17.05 | 21.72 | |  | 18.71 | 4.76 | | 16.77 | | 20.66 |  | 17.84 | 4.05 | | 16.11 | 19.58 | |
| One-week retention | 19.82 | 4.48 | | 17.81 | 21.83 | |  | 19.37 | 5.61 | | 17.08 | | 21.66 |  | 16.76 | 4.07 | | 15.02 | 18.51 | |

[Clause-Final Pause Frequency]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Massed Group | | | | |  | | Short-Spaced Group | | | | | |  | Long-spaced Group | | | | |
|  |  |  | 95% CI | | |  | |  | |  | | 95% CI | |  |  | | 95% CI | | |
|  | *M* | *SD* | | Lower | Upper | |  | *M* | *SD* | | Lower | | Upper |  | *M* | *SD* | | Lower | Upper | |
| Time 1 | 0.94 | 0.16 | | 0.87 | 1.02 | |  | 0.89 | 0.15 | | 0.82 | | 0.95 |  | 0.85 | 0.18 | | 0.77 | 0.94 | |
| Time 2 | 0.93 | 0.16 | | 0.86 | 1.00 | |  | 0.91 | 0.13 | | 0.86 | | 0.97 |  | 0.86 | 0.12 | | 0.81 | 0.91 | |
| Time 3 | 0.99 | 0.13 | | 0.93 | 1.05 | |  | 0.94 | 0.10 | | 0.90 | | 0.98 |  | 0.88 | 0.14 | | 0.82 | 0.94 | |
| Time 4 | 1.00 | 0.16 | | 0.93 | 1.07 | |  | 0.99 | 0.11 | | 0.94 | | 1.04 |  | 0.89 | 0.11 | | 0.84 | 0.94 | |
| Time 5 | 0.96 | 0.15 | | 0.89 | 1.02 | |  | 0.96 | 0.13 | | 0.91 | | 1.01 |  | 0.94 | 0.13 | | 0.89 | 1.00 | |
| Time 6 | 1.03 | 0.12 | | 0.98 | 1.09 | |  | 1.02 | 0.14 | | 0.96 | | 1.08 |  | 0.99 | 0.12 | | 0.94 | 1.04 | |
| One-week retention | 0.99 | 0.13 | | 0.93 | 1.05 | |  | 0.94 | 0.14 | | 0.88 | | 1.00 |  | 0.98 | 0.13 | | 0.92 | 1.03 | |

[Repetitions]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Massed Group | | | | |  | | Short-Spaced Group | | | | | |  | Long-spaced Group | | | | |
|  |  |  | 95% CI | | |  | |  | |  | | 95% CI | |  |  | | 95% CI | | |
|  | *M* | *SD* | | Lower | Upper | |  | *M* | *SD* | | Lower | | Upper |  | *M* | *SD* | | Lower | Upper | |
| Time 1 | 0.38 | 0.26 | | 0.25 | 0.50 | |  | 0.37 | 0.26 | | 0.26 | | 0.48 |  | 0.44 | 0.21 | | 0.35 | 0.54 | |
| Time 2 | 0.41 | 0.22 | | 0.31 | 0.51 | |  | 0.28 | 0.26 | | 0.17 | | 0.38 |  | 0.30 | 0.17 | | 0.23 | 0.37 | |
| Time 3 | 0.34 | 0.25 | | 0.22 | 0.45 | |  | 0.32 | 0.29 | | 0.20 | | 0.44 |  | 0.31 | 0.25 | | 0.21 | 0.42 | |
| Time 4 | 0.35 | 0.25 | | 0.24 | 0.46 | |  | 0.30 | 0.27 | | 0.19 | | 0.41 |  | 0.29 | 0.24 | | 0.19 | 0.39 | |
| Time 5 | 0.28 | 0.28 | | 0.15 | 0.40 | |  | 0.29 | 0.31 | | 0.16 | | 0.41 |  | 0.25 | 0.20 | | 0.16 | 0.34 | |
| Time 6 | 0.34 | 0.30 | | 0.21 | 0.48 | |  | 0.32 | 0.29 | | 0.20 | | 0.44 |  | 0.25 | 0.24 | | 0.14 | 0.35 | |
| One-week retention | 0.44 | 0.26 | | 0.32 | 0.56 | |  | 0.31 | 0.33 | | 0.17 | | 0.44 |  | 0.25 | 0.22 | | 0.16 | 0.35 | |

[Repairs]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Massed Group | | | | |  | | Short-Spaced Group | | | | | |  | Long-spaced Group | | | | |
|  |  |  | 95% CI | | |  | |  | |  | | 95% CI | |  |  | | 95% CI | | |
|  | *M* | *SD* | | Lower | Upper | |  | *M* | *SD* | | Lower | | Upper |  | *M* | *SD* | | Lower | Upper | |
| Time 1 | 2.56 | 1.51 | | 1.85 | 3.27 | |  | 2.09 | 1.41 | | 1.48 | | 2.71 |  | 2.13 | 1.55 | | 1.42 | 2.83 | |
| Time 2 | 3.12 | 1.55 | | 2.42 | 3.82 | |  | 2.15 | 1.37 | | 1.59 | | 2.70 |  | 2.65 | 1.26 | | 2.11 | 3.18 | |
| Time 3 | 2.26 | 1.06 | | 1.78 | 2.73 | |  | 1.89 | 1.62 | | 1.23 | | 2.56 |  | 2.70 | 1.78 | | 1.93 | 3.46 | |
| Time 4 | 2.82 | 1.87 | | 1.97 | 3.66 | |  | 2.40 | 1.46 | | 1.80 | | 3.00 |  | 2.23 | 1.73 | | 1.49 | 2.97 | |
| Time 5 | 3.33 | 1.74 | | 2.55 | 4.11 | |  | 3.01 | 2.23 | | 2.09 | | 3.92 |  | 3.33 | 1.77 | | 2.57 | 4.09 | |
| Time 6 | 3.34 | 1.74 | | 2.56 | 4.12 | |  | 2.63 | 1.85 | | 1.87 | | 3.38 |  | 3.03 | 1.89 | | 2.22 | 3.83 | |
| One-week retention | 3.72 | 1.58 | | 3.01 | 4.43 | |  | 3.00 | 1.81 | | 2.26 | | 3.74 |  | 2.98 | 1.89 | | 2.17 | 3.78 | |

Appendix D: Results of Univariate ANCOVAs for training data

[Time 4]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fluency measure | *df* | MS | *F* | *p* | ηp2 |
| Articulation Rate | | |  |  |  |
| Intercept | 1 | 3339.32 | 11.42 | .00 | .16 |
| Pretest | 1 | 20470.44 | 70.02 | .00 | .53 |
| Condition | 2 | 35.69 | 0.12 | .88 | .00 |
| Error | 60 | 292.33 |  |  |  |
| Mid-clause pause duration | | |  |  |  |
| Intercept | 1 | 0.09 | 8.04 | .00 | .11 |
| Pretest | 1 | 0.39 | 32.94 | .00 | .35 |
| Condition | 2 | 0.06 | 5.64 | .00 | .15 |
| Error | 60 | 0.01 |  |  |  |
| Final-clause pause duration | | |  |  |  |
| Intercept | 1 | 0.93 | 23.69 | .00 | .28 |
| Pretest | 1 | 1.62 | 40.99 | .00 | .40 |
| Condition | 2 | 0.32 | 8.09 | .00 | .21 |
| Error | 60 | 0.04 |  |  |  |
| Final-clause pause frequency | | |  |  |  |
| Intercept | 1 | 0.66 | 56.24 | .00 | .48 |
| Pretest | 1 | 0.29 | 24.70 | .00 | .29 |
| Condition | 2 | 0.04 | 3.60 | .03 | .10 |
| Error | 60 | 0.01 |  |  |  |
| Repetitions | | |  |  |  |
| Intercept | 1 | 0.12 | 2.73 | .10 | .04 |
| Pretest | 1 | 1.13 | 24.53 | .00 | .29 |
| Condition | 2 | 0.04 | .87 | .42 | .02 |
| Error | 60 | 0.04 |  |  |  |

[Time 6]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fluency measure | *df* | MS | *F* | *p* | ηp2 |
| Articulation Rate | | |  |  |  |
| Intercept | 1 | 5031.05 | 16.41 | .00 | .21 |
| Pretest | 1 | 18916.36 | 61.72 | .00 | .50 |
| Condition | 2 | 310.38 | 1.01 | .36 | .03 |
| Error | 60 | 306.46 |  |  |  |
| Mid-clause pause duration | | |  |  |  |
| Intercept | 1 | 0.42 | 32.44 | .00 | .35 |
| Pretest | 1 | 0.14 | 11.22 | .00 | .15 |
| Condition | 2 | 0.01 | 0.93 | .39 | .03 |
| Error | 60 | 0.01 |  |  |  |
| Final-clause pause duration | | |  |  |  |
| Intercept | 1 | 0.99 | 29.64 | .00 | .33 |
| Pretest | 1 | 1.20 | 35.95 | .00 | .37 |
| Condition | 2 | 0.05 | 1.48 | .23 | .04 |
| Error | 60 | 0.03 |  |  |  |
| Final-clause pause frequency | | |  |  |  |
| Intercept | 1 | 0.90 | 73.95 | .00 | .55 |
| Pretest | 1 | 0.23 | 18.82 | .00 | .23 |
| Condition | 2 | 0.00 | 0.18 | .83 | .00 |
| Error | 60 | 0.01 |  |  |  |
| Repetitions | | |  |  |  |
| Intercept | 1 | 0.06 | 1.08 | .30 | .01 |
| Pretest | 1 | 1.33 | 24.08 | .00 | .28 |
| Condition | 2 | 0.10 | 1.87 | .16 | .05 |
| Error | 60 | 0.05 |  |  |  |

[One-week Retention]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fluency measure | *df* | MS | *F* | *p* | ηp2 |
| Articulation Rate | | |  |  |  |
| Intercept | 1 | 4401.31 | 14.86 | .00 | .20 |
| Pretest | 1 | 15930.53 | 53.80 | .00 | .47 |
| Condition | 2 | 471.62 | 1.59 | .21 | .05 |
| Error | 59 | 296.07 |  |  |  |
| Mid-clause pause duration | | |  |  |  |
| Intercept | 1 | 0.15 | 13.17 | .00 | .18 |
| Pretest | 1 | 0.40 | 33.92 | .00 | .36 |
| Condition | 2 | 0.00 | 0.23 | .79 | .00 |
| Error | 59 | 0.01 |  |  |  |
| Final-clause pause duration | | |  |  |  |
| Intercept | 1 | 1.10 | 23.84 | .00 | .28 |
| Pretest | 1 | 1.19 | 25.69 | .00 | .30 |
| Condition | 2 | 0.04 | 0.91 | .40 | .03 |
| Error | 59 | 0.04 |  |  |  |
| Final-clause pause frequency | | |  |  |  |
| Intercept | 1 | 0.75 | 54.64 | .00 | .48 |
| Pretest | 1 | 0.25 | 18.24 | .00 | .23 |
| Condition | 2 | 0.01 | 1.07 | .34 | .03 |
| Error | 59 | 0.01 |  |  |  |
| Repetitions | | |  |  |  |
| Intercept | 1 | 0.07 | 1.37 | .24 | .02 |
| Pretest | 1 | 1.51 | 29.27 | .00 | .33 |
| Condition | 2 | 0.24 | 4.67 | .01 | .13 |
| Error | 59 | 0.05 |  |  |  |

Appendix E. Results of Multiple Comparison of Training Task Performance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **[Time 4]** | *Adjusted M* | 95% CI | Short-spaced | Long-spaced |
| Articulation rate |  |  |  |  |
| Massed | 159.396 | [151.73, 167.07] | -0.02 [-0.62, 0.58]  *p* = 1.00 | 0.12 [-0.49, 0.73]  *p* = 1.00 |
| Short-spaced | 159.745 | [152.59,166.90] |  | 0.14 [-0.47, 0.76]  *p* = 1.00 |
| Long-spaced | 157.315 | [149.76,164.87] |  |  |
| Mid-clause pause duration |  |  |  |  |
| Massed | -0.01 | [-0.60, .038] | 0.22 [-0.38, 0.83]  *p* = 1.00 | -0.73 [-1.37, -0.10]  *p* = .06+ |
| Short-spaced | -0.04 | [-.081, .010] |  | -0.99 [-1.64, -0.34] *p* = .006\* |
| Long-spaced | 0.07 | [.023, .119] |  |  |
| Clause-final pause duration |  |  |  |  |
| Massed | 1.22 | [1.13, 1.31] | -0.09 [-0.69, 0.51] *p* = 1.0 | -1.09 [-1.75, -0.44] *p* = .002\* |
| Short-spaced | 1.24 | [1.16, 1.32] |  | -1.04 [-1.69, -0.38] *p* = .004\* |
| Long-spaced | 1.45 | [1.36, 1.53] |  |  |
| Clause-final pause frequency |  |  |  |  |
| Massed | 0.976 | [0.93, 1.02] | -0.13 [-0.73, 0.47] *p* = 1.0 | 0.61 [-0.01, 1.24] *p* = .15 |
| Short-spaced | 0.991 | [0.95, 1.04] |  | 0.78 [0.14, 1.41] *p* = .03\* |
| Long-spaced | 0.907 | [0.86, 0.95] |  |  |
| Repetitions |  |  |  |  |
| Massed | 0.35 | [0.25, 0.45] | 0.15 [-0.45, 0.75] *p* = 1.0 | 0.4 [-0.22, 1.02] *p* = .58 |
| Short-spaced | 0.316 | [0.23, 0.41] |  | 0.25 [-0.36, 0.87] *p* = 1.0 |
| Long-spaced | 0.262 | [0.17, 0.36] |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **[Time 6]** | *Adjusted M* | 95% CI | Short-spaced | Long-spaced |
| Articulation rate |  |  |  |  |
| Massed | 164.59 | [156.74, 172,44] | -0.24 [-0.84, 0.36] *p* = 1.0 | 0.18 [-0.43, 0.80] *p* = 1.0 |
| Short-spaced | 168.90 | [161.57, 176.22] |  | 0.42 [-0.18, 1.02] *p* = .48 |
| Long-spaced | 161.33 | [153.60, 169.06] |  |  |
| Mid-clause pause duration |  |  |  |  |
| Massed | -0.06 | [-0.11, -0.01] | 0.27 [-0.33, 0.88] *p* = 1.0 | -0.11 [-0.72, 0.50] *p* = 1.0 |
| Short-spaced | -0.09 | [-0.14, -0.04] |  | -0.39 [-0.98, 0.21]  *p* = .57 |
| Long-spaced | -0.05 | [-0.10, 0.00] |  |  |
| Clause-final pause duration |  |  |  |  |
| Massed | 1.17 | [1.09, 1.26] | -0.17 [-0.77, 0.43] *p* = 1.0 | -0.52 [-1.14, 0.11] *p* = .29 |
| Short-spaced | 1.21 | [1.13, 1.28] |  | -0.35 [-0.94, 0.25] *p* = .74 |
| Long-spaced | 1.27 | [1.19, 1.35] |  |  |
| Clause-final pause frequency |  |  |  |  |
| Massed | 1.01 | [0.96, 1.06] | -0.12 [-0.72, 0.48] *p* = 1.0 | 0.04 [-0.57, 0.66] *p* = 1.0 |
| Short-spaced | 1.02 | [0.98, 1.07] |  | 0.17 [-0.42, 0.76] *p* = 1.0 |
| Long-spaced | 1.00 | [0.95, 1.05] |  |  |
| Repetitions |  |  |  |  |
| Massed | 0.35 | [0.24, 0.45] | 0.05 [-0.55, 0.65] *p* = 1.0 | 0.54 [-0.09, 1.16] *p* = .25 |
| Short-spaced | 0.34 | [0.24, 0.43] |  | 0.48 [-0.12, 1.08] *p* = .33 |
| Long-spaced | 0.22 | [0.12, 0.32] |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **[One-week Retention]** | *Adjusted M* | 95% CI | Short-spaced | Long-spaced |
| Articulation rate |  |  |  |  |
| Massed | 156.48 | [148.54, 164.54] | 0.44 [-0.16, 1.05] *p* = .43 | -0.02 [-0.63, 0.59] *p* = 1.0 |
| Short-spaced | 148.61 | [141.41, 155.81] |  | -0.47 [-1.07, 0.13] *p* = .36 |
| Long-spaced | 156.85 | [149.24, 164.46] |  |  |
| Mid-clause pause duration |  |  |  |  |
| Massed | 0.00 | [-0.05, 0.05] | 0.03 [-0.57, 0.63] *p* = 1.0 | 0.18 [-0.43, 0.80] *p* = 1.0 |
| Short-spaced | 0.00 | [-0.05, 0.05] |  | 0.16 [-0.43, 0.75] *p* = 1.0 |
| Long-spaced | -0.02 | [-0.07, 0.03] |  |  |
| Clause-final pause duration |  |  |  |  |
| Massed | 1.20 | [1.10, 1.30] | -0.41 [-1.01, 0.20] *p* = .55 | -0.18 [-0.79, 0.43] *p* = 1.0 |
| Short-spaced | 1.30 | [1.20, 1.39] |  | 0.23 [-0.36, 0.83] *p* = 1.0 |
| Long-spaced | 1.24 | [1.15, 1.34] |  |  |
| Clause-final pause frequency |  |  |  |  |
| Massed | 0.97 | [0.91, 1.02] | 0.22 [-0.38, 0.82] *p* = 1.0 | -0.2 [-0.82, 0.41] *p* = 1.0 |
| Short-spaced | 0.94 | [0.89, 0.99] |  | -0.43 [-1.03, 0.17] *p* = .44 |
| Long-spaced | 0.99 | [0.94, 1.04] |  |  |
| Repetitions |  |  |  |  |
| Massed | 0.45 | [0.34, 0.55] | 0.05 [-0.11, 1.11] *p* = .30 | 0.94 [0.29, 1.58] *p* = .01\* |
| Short-spaced | 0.33 | [0.23, 0.42] |  | 0.44 [-0.16, 1.04] *p* = .42 |
| Long-spaced | 0.23 | [0.13, 0.33] |  |  |

Appendix F: Descriptive statistics for pretest, immediate posttest and delayed posttest

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Pretest | | | | | | | | | |  | Immediate Posttest | | | | | |  | | Delayed Posttest | | | | | | |
|  |  | | |  | 95% CI | | | | | |  |  | |  | | 95% CI | |  | |  | | |  | | 95% CI | |
|  | M | | SD | | | | Lower | | Upper | |  | M | SD | | Lower | | Upper |  | | M | | SD | | | Lower | Upper |
| Articulation rate |  |  | | | |  | |  | |  | |  |  | |  | |  |  |  | |  | | |  | |  |
| Massed Group | 166.87 | 25.01 | | | | 155.17 | | 178.58 | |  | | 144.03 | 22.55 | | 134.15 | | 153.92 |  | 156.74 | | 20.23 | | | 147.87 | | 165.61 |
| Short-spaced Group | 163.74 | 38.01 | | | | 147.31 | | 180.18 | |  | | 155.40 | 30.77 | | 142.82 | | 167.98 |  | 153.83 | | 30.59 | | | 141.33 | | 166.33 |
| Long-spaced Group | 162.32 | 31.96 | | | | 147.77 | | 176.86 | |  | | 180.99 | 20.62 | | 153.17 | | 170.80 |  | 158.83 | | 25.55 | | | 147.90 | | 169.75 |
| Control Group | 180.13 | 31.39 | | | | 162.75 | | 197.51 | |  | | 180.10 | 24.02 | | 167.94 | | 192.25 |  | 159.59 | | 27.29 | | | 145.78 | | 173.40 |
| Mid-clause pause duration |  |  | | | |  | |  | |  | |  |  | |  | |  |  |  | |  | | |  | |  |
| Massed Group | 1.28 | 0.57 | | | | 1.02 | | 1.55 | |  | | 1.45 | 0.53 | | 1.22 | | 1.69 |  | 1.40 | | 0.54 | | | 1.16 | | 1.63 |
| Short-spaced Group | 1.54 | 0.56 | | | | 1.29 | | 1.78 | |  | | 1.25 | 0.38 | | 1.09 | | 1.41 |  | 1.35 | | 0.47 | | | 1.15 | | 1.54 |
| Long-spaced Group | 1.48 | 0.50 | | | | 1.26 | | 1.71 | |  | | 1.46 | 0.64 | | 1.19 | | 1.73 |  | 1.42 | | 0.44 | | | 1.23 | | 1.61 |
| Control Group | 1.22 | 0.27 | | | | 1.07 | | 1.38 | |  | | 1.10 | 0.24 | | 0.98 | | 1.23 |  | 1.14 | | 0.28 | | | 0.99 | | 1.29 |
| Final-clause pause duration |  |  | | | |  | |  | |  | |  |  | |  | |  |  |  | |  | | |  | |  |
| Massed Group | 0.26 | 0.24 | | | | 0.14 | | 0.38 | |  | | 0.27 | 0.21 | | 0.17 | | 0.37 |  | 0.24 | | 0.18 | | | 0.16 | | 0.32 |
| Short-spaced Group | 0.32 | 0.17 | | | | 0.25 | | 0.40 | |  | | 0.31 | 0.19 | | 0.23 | | 0.39 |  | 0.31 | | 0.19 | | | 0.23 | | 0.39 |
| Long-spaced Group | 0.43 | 0.17 | | | | 0.35 | | 0.51 | |  | | 0.37 | 0.19 | | 0.29 | | 0.45 |  | 0.32 | | 0.18 | | | 0.24 | | 0.40 |
| Control Group | 0.21 | 0.18 | | | | 0.10 | | 0.31 | |  | | 0.24 | 0.15 | | 0.16 | | 0.32 |  | 0.27 | | 0.17 | | | 0.18 | | 0.36 |
| Mid-clause pause frequency |  |  | | | |  | |  | |  | |  |  | |  | |  |  |  | |  | | |  | |  |
| Massed Group | 21.15 | 7.56 | | | | 17.61 | | 24.69 | |  | | 18.35 | 4.28 | | 16.47 | | 20.23 |  | 19.27 | | 7.39 | | | 16.03 | | 22.51 |
| Short-spaced Group | 19.39 | 6.18 | | | | 16.72 | | 22.06 | |  | | 21.40 | 6.69 | | 18.67 | | 24.13 |  | 18.25 | | 6.89 | | | 15.43 | | 21.06 |
| Long-spaced Group | 18.80 | 5.28 | | | | 16.39 | | 21.20 | |  | | 20.38 | 6.27 | | 17.70 | | 23.07 |  | 19.59 | | 4.52 | | | 17.65 | | 21.52 |
| Control Group | 22.07 | 6.06 | | | | 1.57 | | 18.71 | |  | | 22.63 | 1.88 | | 21.90 | | 23.81 |  | 20.66 | | 5.52 | | | 17.86 | | 23.45 |
| Final-clause pause frequency |  |  | | | |  | |  | |  | |  |  | |  | |  |  |  | |  | | |  | |  |
| Massed Group | 8.20 | 3.27 | | | | 6.67 | | 9.73 | |  | | 5.27 | 2.61 | | 4.12 | | 6.41 |  | 7.99 | | 3.34 | | | 6.53 | | 9.45 |
| Short-spaced Group | 6.68 | 2.97 | | | | 5.39 | | 7.96 | |  | | 6.16 | 2.13 | | 5.29 | | 7.04 |  | 7.33 | | 3.51 | | | 5.90 | | 8.77 |
| Long-spaced Group | 6.25 | 3.38 | | | | 4.71 | | 7.79 | |  | | 5.42 | 2.22 | | 4.47 | | 6.37 |  | 6.67 | | 2.70 | | | 5.51 | | 7.82 |
| Control Group | 7.05 | 3.06 | | | | 5.35 | | 8.74 | |  | | 7.26 | 2.49 | | 5.99 | | 8.52 |  | 6.97 | | 2.55 | | | 5.68 | | 8.26 |
| Repetitions |  |  | | | |  | |  | |  | |  |  | |  | |  |  |  | |  | | |  | |  |
| Massed Group | 0.40 | 0.24 | | | | 0.28 | | 0.51 | |  | | 0.51 | 0.27 | | 0.39 | | 0.63 |  | 0.38 | | 0.26 | | | 0.27 | | 0.50 |
| Short-spaced Group | 0.40 | 0.25 | | | | 0.29 | | 0.51 | |  | | 0.27 | 0.26 | | 0.16 | | 0.38 |  | 0.32 | | 0.23 | | | 0.22 | | 0.42 |
| Long-spaced Group | 0.31 | 0.22 | | | | 0.20 | | 0.41 | |  | | 0.33 | 0.22 | | 0.23 | | 0.42 |  | 0.35 | | 0.28 | | | 0.23 | | 0.47 |
| Control Group | 0.40 | 0.26 | | | | 0.26 | | 0.55 | |  | | 0.43 | 0.18 | | 0.33 | | 0.52 |  | 0.40 | | 0.25 | | | 0.28 | | 0.53 |
| Repairs |  |  | | | |  | |  | |  | |  |  | |  | |  |  |  | |  | | |  | |  |
| Massed Group | 0.46 | 0.20 | | | | 0.37 | | 0.56 | |  | | 0.52 | 0.19 | | 0.44 | | 0.60 |  | 0.51 | | 0.23 | | | 0.40 | | 0.61 |
| Short-spaced Group | 0.46 | 0.25 | | | | 0.35 | | 0.57 | |  | | 0.59 | 0.23 | | 0.49 | | 0.68 |  | 0.46 | | 0.20 | | | 0.37 | | 0.54 |
| Long-spaced Group | 0.38 | 0.29 | | | | 0.25 | | 0.51 | |  | | 0.54 | 0.22 | | 0.44 | | 0.63 |  | 0.49 | | 0.22 | | | 0.39 | | 0.58 |
| Control Group | 0.51 | 0.19 | | | | 0.41 | | 0.61 | |  | | 0.57 | 0.24 | | 0.45 | | 0.69 |  | 0.56 | | 0.23 | | | 0.44 | | 0.67 |

Appendix G: Results of Mixed ANCOVAs on the posttests

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Condition | | |  | Time | | |  | Condition × Time | | |
|  | *F* | *p* | *ηp2* |  | *F* | *p* | *ηp2* |  | *F* | *p* | *ηp2* |
| Articulation rate | 3.33 | .02\* | 0.12 |  | 0.74 | .39 | 0.01 |  | 7.11 | <.001\* | .22 |
| Mid-clause pause dur. | 2.13 | .10 | 0.08 |  | 0.01 | .93 | 0.00 |  | 0.46 | .71 | .02 |
| Clause-final pause dur. | 0.16 | .93 | .01 |  | 2.61 | .11 | 0.04 |  | 1.42 | .24 | .06 |
| Mid-clause pause freq. | 2.50 | .07+ | .09 |  | 4.07 | .05\* | 0.05 |  | 2.91 | .04\* | .11 |
| Clause-final pause freq. | 0.79 | .50 | .03 |  | 1.36 | .25 | 0.02 |  | 2.76 | .05+ | .10 |
| Repetitions | 3.00 | .04\* | .11 |  | 0.06 | .80 | 0.00 |  | 1.80 | .15 | .07 |
| Repairs | 0.20 | .90 | .01 |  | 2.00 | .16 | 0.03 |  | 0.96 | .42 | .04 |

Note. *p* < .05

Appendix H: Results of Univariate ANCOVAs on the posttests

[Immediate Posttest]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fluency measure | *df* | MS | *F* | *p* | ηp2 |
| Articulation Rate | | |  |  |  |
| Intercept | 1 | 7897.45 | 35.96 | .00 | .32 |
| Pretest | 1 | 30825.14 | 140.36 | .00 | .65 |
| Condition | 3 | 2547.13 | 11.59 | .00 | .32 |
| Error | 74 | 219.60 |  |  |  |
| Mid-clause pause frequency | | |  |  |  |
| Intercept | 1 | 13339.09 | 31.17 | .00 | .29 |
| Pretest | 1 | 4494.27 | 10.50 | .00 | .12 |
| Condition | 3 | 1467.77 | 3.43 | .02 | .12 |
| Error | 74 | 427.92 |  |  |  |
| Final-clause pause frequency | | |  |  |  |
| Intercept | 1 | 177.49 | 39.24 | .00 | .34 |
| Pretest | 1 | 80.26 | 17.74 | .00 | .19 |
| Condition | 3 | 17.14 | 3.79 | .01 | .13 |
| Error | 74 | 4.52 |  |  |  |
| Repetitions | | |  |  |  |
| Intercept | 1 | .718 | 17.20 | .00 | .19 |
| Pretest | 1 | 1.26 | 30.19 | .00 | .29 |
| Condition | 3 | 0.20 | 4.91 | .00 | .16 |
| Error | 73 | 0.04 |  |  |  |

[Delayed Posttest]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fluency measure | *df* | MS | *F* | *p* | ηp2 |
| Articulation Rate | | |  |  |  |
| Intercept | 1 | 11318.85 | 29.31 | .00 | .28 |
| Pretest | 1 | 23268.84 | 60.26 | .00 | .44 |
| Condition | 3 | 248.22 | 0.64 | .59 | .02 |
| Error | 74 | 386.12 |  |  |  |
| Mid-clause pause frequency | | |  |  |  |
| Intercept | 1 | 6114.86 | 16.83 | .00 | .18 |
| Pretest | 1 | 12008.92 | 33.05 | .00 | .30 |
| Condition | 3 | 582.93 | 1.60 | .19 | .06 |
| Error | 74 | 363.33 |  |  |  |
| Final-clause pause frequency | | |  |  |  |
| Intercept | 1 | 283.24 | 33.71 | .00 | .31 |
| Pretest | 1 | 97.27 | 11.57 | .00 | .13 |
| Condition | 3 | 2.02 | 0.24 | .86 | .01 |
| Error | 74 | 8.40 |  |  |  |
| Repetitions | | |  |  |  |
| Intercept | 1 | 0.61 | 12.15 | .00 | .14 |
| Pretest | 1 | 1.22 | 24.43 | .00 | .25 |
| Condition | 3 | 0.32 | 0.596 | .62 | .02 |
| Error | 73 | 0.05 |  |  |  |

Appendix I. Results of Multiple Comparison for Posttests

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **[Immediate Posttest]** | *Adjusted M* | 95% CI | Short-spaced | Long-spaced | Control |
| Articulation rate |  |  |  |  |  |
| Massed | 144.28 | [137.68, 150.88] | -0.88 [-1.51, -0.25] *p* = .02 | -1.38 [-2.06, -0.69] *p* < .001 | -1.73 [-2.06, -0.95] *p* < .001 |
| Short-spaced | 157.62 | [151.45, 163.78] |  | -0.49 [-1.10, 0.11] *p* = .59 | -0.94 [-1.63, -0.26] *p* = .03 |
| Long-spaced | 165.10 | [158.64, 171.57] |  |  | -0.43 [-1.10, -0.24] *p* = 1.0 |
| Control | 172.01 | [164.26, 179.75] |  |  |  |
| Mid-clause pause frequency |  |  |  |  |  |
| Massed | 28.51 | [19.28, 37.73] | -0.62 [-1.23, 0.00] *p* = .25 | -0.63 [-1.25, 0.00] *p* = .27 | -0.98 [-1.69, -0.27] *p* = .01 |
| Short-spaced | 41.54 | [32.94, 50.14] |  | -0.01 [-0.60, 0.58] *p* = 1.0 | -0.42 [-1.08, 0.24] *p* = 1.0 |
| Long-spaced | 41.77 | [32.70, 50.85] |  |  | -0.39 [-1.06, 0.28] *p* = 1.0 |
| Control | 50.48 | [39.71, 61.24] |  |  |  |
| Clause-final pause frequency |  |  |  |  |  |
| Massed | 4.88 | [3.92, 5.85] | -0.64 [-1.25, -0.02] *p* = .23 | -0.36 [-0.98, 0.26] *p* = 1.0 | -1.02 [-1.73, -0.31] *p* = .01 |
| Short-spaced | 6.28 | [5.39, 7.16] |  | 0.28 [-0.32, 0.87] *p* = 1.0 | -0.45 [-1.11, 0.21] *p* = 1.0 |
| Long-spaced | 5.67 | [4.74, 6.60] |  |  | -0.68 [-1.37, 0.00] *p* = .19 |
| Control | 7.25 | [6.15, 8.34] |  |  |  |
| Repetitions |  |  |  |  |  |
| Massed | 0.49 | [0.40, 0.58] | 1.13 [0.48, 1.77] *p* = .002 | 0.61 [-0.02, 1.24] *p* = .29 | 0.38 [-0.30, 1.05] *p* = 1.0 |
| Short-spaced | 0.26 | [0.17, 0.34] |  | -0.52 [-1.12, 0.08] *p* = .52 | -0.73 [-1.40, -0.06] *p* = .16 |
| Long-spaced | 0.37 | [0.27, 0.45] |  |  | -0.20 [-0.87, 0.46] *p* = 1.0 |
| Control | 0.41 | [0.30, 0.52] |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **[Delayed Posttest]** | *Adjusted M* | 95% CI | Short-spaced | Long-spaced | Control |
| Articulation rate |  |  |  |  |  |
| Massed | 156.96 | [148.20, 165.71] | 0.06 [-0.54, 0.66] *p* = 1.0 | -0.23 [-0.84, 0.39] *p* = 1.0 | 0.21 [-0.46, 0.88] *p* = 1.0 |
| Short-spaced | 155.76 | [147.58, 163.93] |  | -0.29 [-0.88, 0.31] *p* = 1.0 | 0.16 [-0.49. 0.81] *p* = 1.0 |
| Long-spaced | 161.53 | [152.96, 170.11] |  |  | 0.42 [-0.25, 1.09] *p* = 1.0 |
| Control | 152.56 | [142.29, 162.83] |  |  |  |
| Mid-clause pause frequency |  |  |  |  |  |
| Massed | 36.47 | [27.97, 44.97] | 0.07 [-0.53, 0.67] *p* = 1.0 | -0.45 [-1.07, 0.17] *p* = .89 | -0.40 [-1.08, 0.27]  *p* = 1.0 |
| Short-spaced | 35.08 | [27.15, 43.00] |  | -0.53 [-1.13, 0.07] *p* = .47 | -0.50 [-1.16, 0.16] *p* = .80 |
| Long-spaced | 45.35 | [36.99, 53.71] |  |  | 0.03 [-0.63, 0.69] *p* = 1.0 |
| Control | 44.77 | [34.85, 54.68] |  |  |  |
| Clause-final pause frequency |  |  |  |  |  |
| Massed | 7.57 | [6.25, 8.88] | 0.04 [-0.56, 0.64] *p* = 1.0 | 0.21 [-0.41, 0.82] *p* = 1.0 | 0.19 [-0.48, 0.86] *p* = 1.0 |
| Short-spaced | 7.46 | [6.25, 8.66] |  | 0.17 [-0.42, 0.76] *p* = 1.0 | 0.17 [-0.48, 0.82] *p* = 1.0 |
| Long-spaced | 6.95 | [5.67, 8.22] |  |  | 0.00 [-0.67, 0.66] *p* = 1.0 |
| Control | 6.96 | [5.47, 8.45] |  |  |  |
| Repetitions |  |  |  |  |  |
| Massed | 0.37 | [0.27, 0.47] | 0.27 [-0.33, 0.87] *p* = 1.0 | -0.08 [-0.70, 0.53] *p* = 1.0 | -0.07 [-0.74, 0.60] *p* = 1.0 |
| Short-spaced | 0.31 | [0.21, 0.40] |  | -0.35 [-0.94, 0.25] *p* = 1.0 | -0.34 [-0.99, 0.32] *p* = 1.0 |
| Long-spaced | 0.39 | [0.29, 0.49] |  |  | 0.01 [-0.65, 0.67] *p* = 1.0 |
| Control | 0.39 | [0.27, 0.50] |  |  |  |

Appendix J. Results of Brief Questionnaire

According to Kruskal-Wallis tests, the participants in the massed practice group felt more bored and less concentrated during the task performance than those assigned to the other groups, *X*2(2, *N* = 64) = 13.59, *p* = .001, and *X*2(2, *N* = 64) = 7.59, *p* = .02, respectively. Note that the difference between massed and short-spaced groups did not reach significance for the item on concentration (*p* = .21).

**[Results of multiple comparisons for questionnaire items among three groups]**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Mean (SD) | Short-spaced | Long-spaced |
| I got bored of performing the same task repeatedly. | | | |
| Massed | 5.10 (1.29) | *p* = .001 | *p* =.03 |
| Short-spaced | 3.43 (1.38) |  | *p* =.99 |
| Long-spaced | 3.95 (1.36) |  |  |
| I lost my attention during the training. | | | |
| Massed | 4.40 (1.43) | *p* =.21 | *p* =.02 |
| Short-spaced | 3.57 (1.67) |  | *p* =.98 |
| Long-spaced | 3.10 (1.45) |  |  |