Visualisation Project – COSC3000 2024 S1

By Joy Yin – s4740051

- CA4 (“Ellie”) was excluded to ensure correct replication of thesis results.
- Note: colours, size and formatting have been configured with the intention of being displayed on a laptop screen.

REPLICATION OF THESIS GRAPHS:

- Replaced original boxplots with normal error bars to reduce visual complexity and increase readability.
- Used different data point markers to separate ‘before’ and ‘after’ training data points.
- Added horizontal lines to increase visual identification of data points in relation to y-axis.
- Used blue markers and error bars to visually differentiate the statistically significant differences.
    - First tried green but the colour difference was not obvious and may not cater to colour-impaired viewers (see Appendix 1).

On the left is a heavily annotated visualisation that makes it explicitly clear what the graph markings represent; however, the trade-off is that it’s harder to focus on the data due to its noisy appearance. On the right, the colour legend has been included back in as the representation of a blue marking is not a universal standard and may not be clear to viewers. At the bottom is an example of the Untrained Dyad results which do not have any statistically significant results.

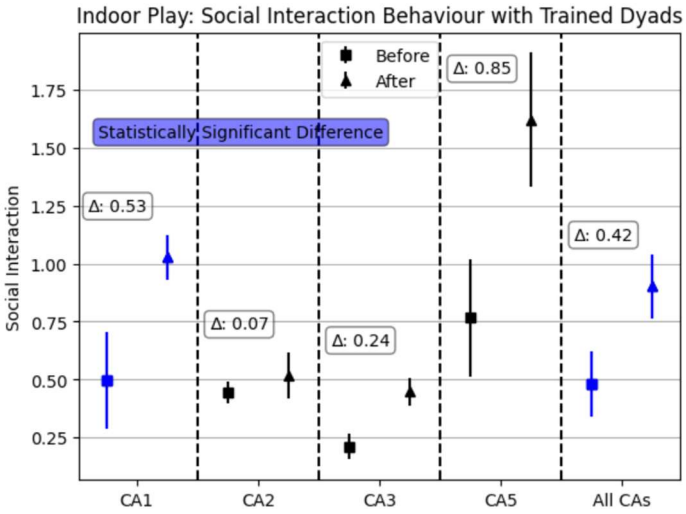


Figure 1: Social Indoor Play with Trained Dyads – including statistical significance and labelled differences.

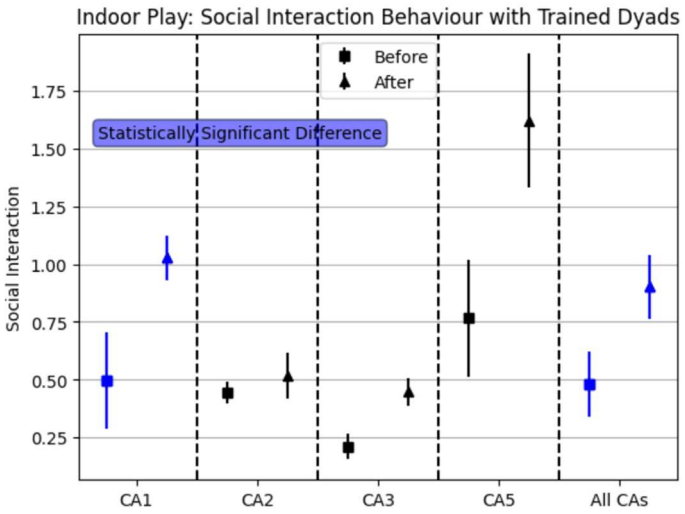


Figure 2: Social Indoor Play with Trained Dyads – only including statistical significance.

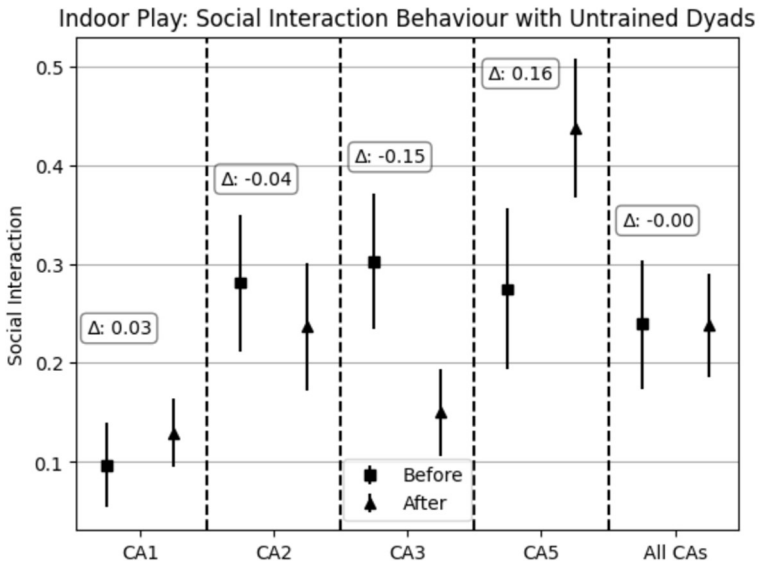


Figure 3: Social Indoor Play with Untrained Dyads.

DEMONSTRATING INDIVIDUAL SESSION DATA – REPLICATION:

- Changed from error bar graph to boxplot to increase area of comparison between the average score and individual session data points.
- Different colours were used to differentiate 'Before' and 'After' training plots.
    - Instead of using a different marker in the box to replace the mean line, as otherwise it would be harder to differentiate between the mean point and individual session data points.
- Colour-blind consideration: used yellow and red to symbolise before and after; used blue to symbolise statistical significance.
    - A black border was added around 'Before' training yellow session data points to help the small points standout against the white background.
- Lines were not used to connect individual session data points as there is no meaningful sequence to demonstrate.
- I considered using black background (see Appendix 2 for an example)
    - It would reduce glare and eyestrain on laptop screens and provide higher contrast.
    - However, this format is not widely used in scientific journals and may fail to cater to viewers with contrast sensitivity, laptops with poorer screen quality (fails to render black background accurately) and laptop compatibility.

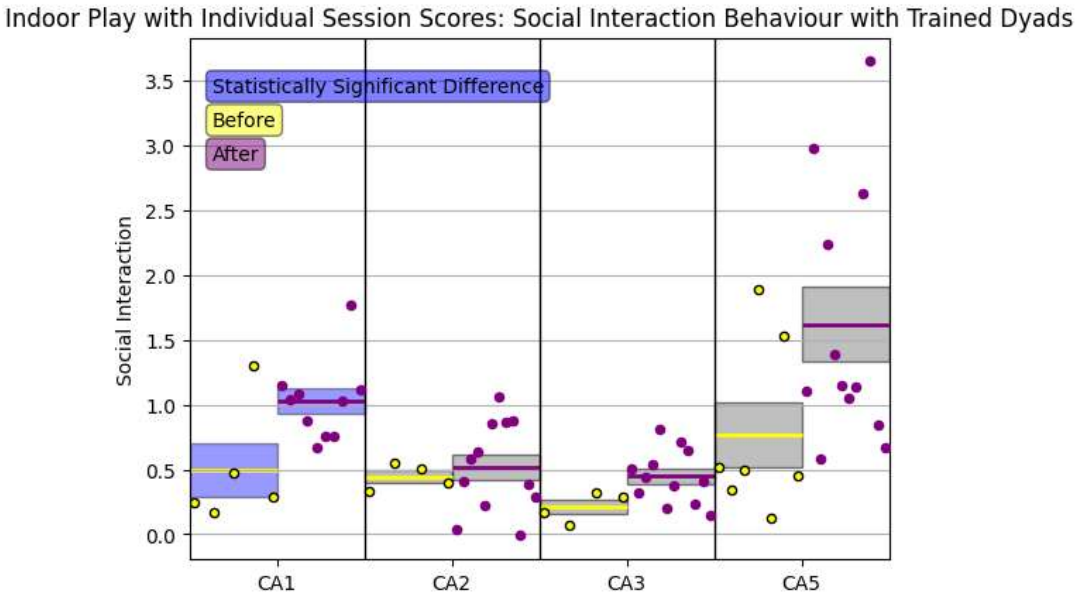


Figure 4: Social Indoor Play with Trained Dyads – including individual session data with box plots.

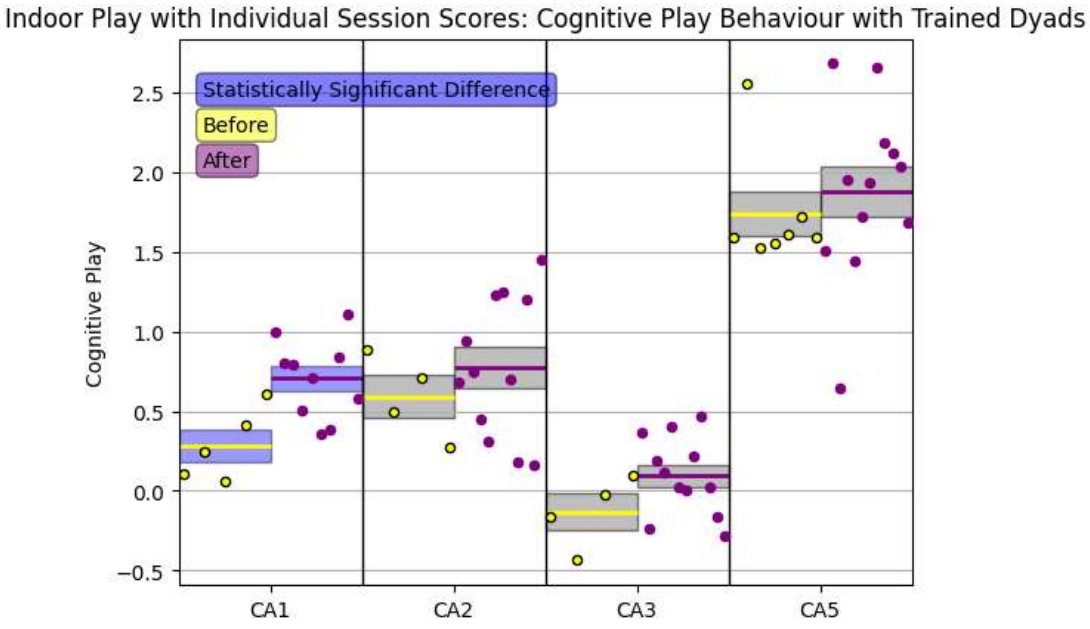


Figure 5: Cognitive Indoor Play with Trained Dyads – including individual session data with box plots.

DEMONSTRATING INDIVIDUAL SESSION DATA – VERSION 2:

- Replaced session averages with a triangular data point.
- As the data from 'before' training to 'after' training can be thought as sequential, I joined the two with a linear average line to demonstrate the change.
- Used a grey/blue fill to represent the uncertainty $_{point}$ changing from 'before' to 'after'.
- Added an inset to provide a clearer picture of CA2 and CA3.

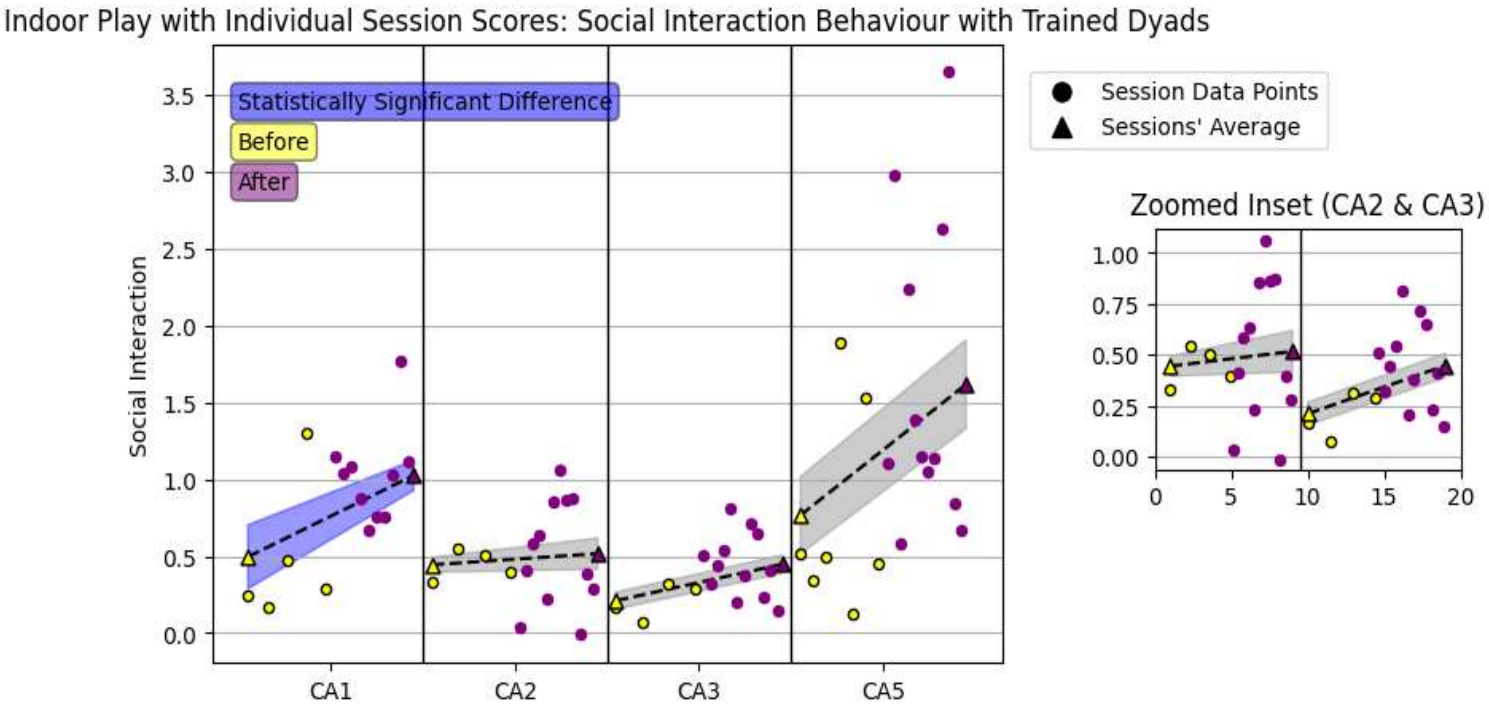


Figure 6: Social Indoor Play with Trained Dyads – including individual session data with polygonal uncertainty patches and zoomed inset.

DEMONSTRATING INDIVIDUAL SESSION DATA – VERSION 3:

- Used violin plot to demonstrate the spread of data and the probability density of the session score values.
- This graph provides additional insight into the spread of individual session data points in relation to the average across sessions.
- However, the drawback is that the uncertainty range is no longer displayed.
- The violin plot was made wider to provide more visual comparison area between the plot and individual session data points.

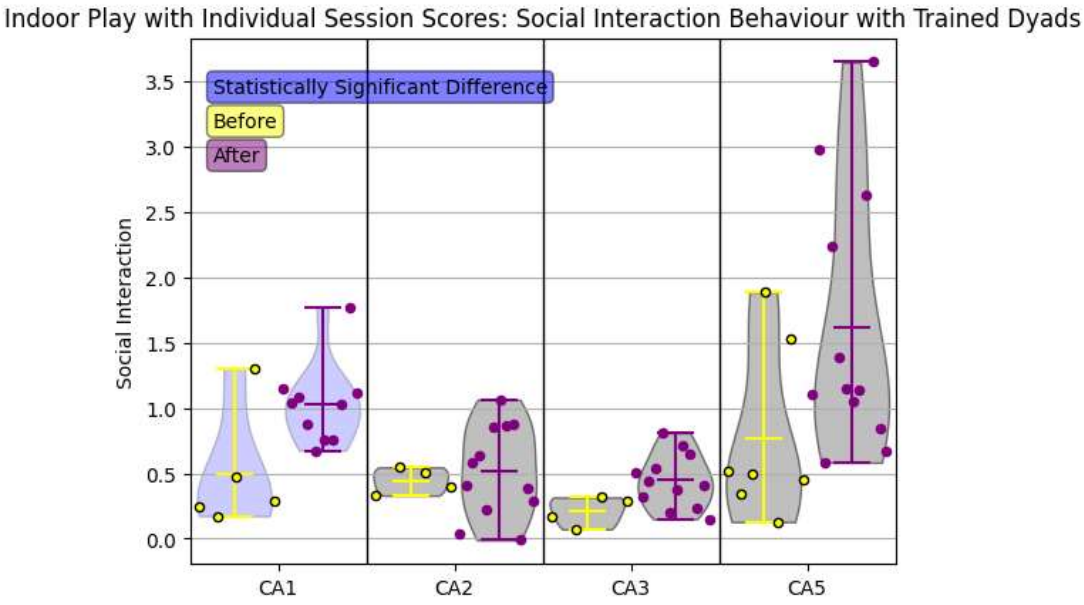


Figure 7: Social Indoor Play with Trained Dyads – including individual session data with violin plots.

DEMONSTRATING INDIVIDUAL SESSION DATA – COGNITIVE AND SOCIAL COMBINED:

- I thought to experiment with visualising all session data points across cognitive and social on the same graph as they shared the same y-axis and x-axis.
- Cognitive session points were represented with a circular data point and social session points were represented with a triangular data point to clearly differentiate the two.
- To calculate the propagated uncertainty for the average of both cognitive and social sessions, the following link was used to find the formula:
- A function was created to calculate the propagated uncertainty for the average of both cognitive and social sessions, referencing http://spiff.rit.edu/classes/phys207/lectures/uncerts/uncerts.html.

```python
# calculate propagated uncertainty
def calc_propgated_uncertainty(a, b, avg):
    return np.sqrt((a-avg)**2 + (b-avg)**2)
```

Figure 8: Code snippet of propagated uncertainty calculation.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \mu)^2}{N-1}}$$

Figure 9: Formula of propagated uncertainty calculation.

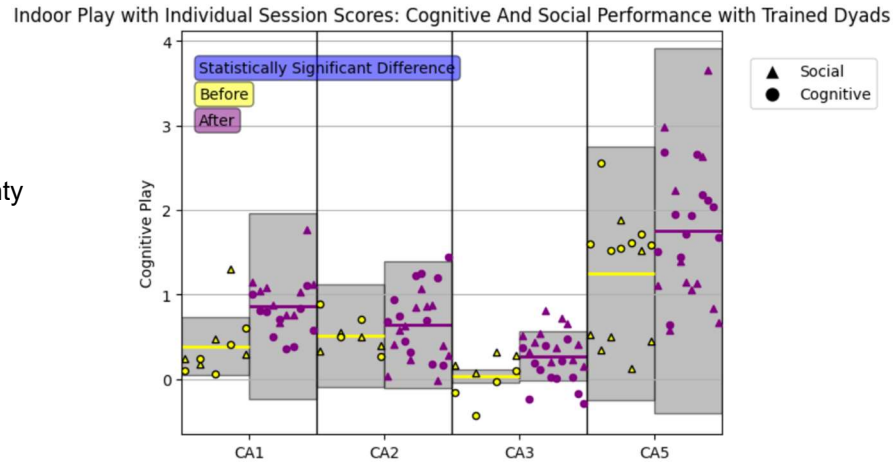


Figure 10: Social and Cognitive Indoor Play with Trained Dyads – individual session data with propagated uncertainty box plots.

- The propagated uncertainty resulted in no statistical significance after combining all sessions for cognitive and social as cognitive scores on average were lower across all CAs than social scores.
- This visualisation seems to not be meaningful as whilst the y-axis is the same 'unit' across cognitive and social session data points, performance in cognitive and social behaviour may not be related to each other and is not meaningful when plotted together.

CHANGING COGNITIVE AND SOCIAL WEIGHTINGS:

Cognitive		
Sub-Category	Previous Weight	New Weight
Non-play	-1	-1
Stereotype	0	0
Exploratory	1	1
Functional	2	3
Constructive	2	2
Symbolic	3	4
Rule-governed	5	5

Table 1: Previous and new cognitive weights

Functional play was changed from 2 to 3 as it demonstrated that the CA understands and exemplifies a play object's intended use. Constructive remains lower as it does not necessarily suggest the CA is using it for socially accepted play usages. Symbolic play was moved up to 4 as it suggests the CA also understands intangible play concepts involving the object.

Social		
Sub-Category	Previous Weight	New Weight
Negative	-1	-2
No interaction	0	-1
Passive-low	1	0
Passive-high	2	2
Unilateral	2	4
Active-low	3	3
Active-high	5	5

Table 2: Previous and new social weights

Negative social interactions were demoted to -2 as this response is seen to be less socially accepted than no interaction. No interaction was also demoted to -1 as it's not a stereotypical social response in play settings. Passive-low can be seen as the minimum threshold for socially acceptable responses. Unilateral has been increased to 4 and above active-low as it the thesis design suggests that while the CA is initiating, the peer is responding negatively which requires significantly higher social capacity to handle.

Table 3: Results for Social Indoor Play with Trained Dyads (Changed Weights)

Trained				
CA	**Pre**	**Post**	**Change**	p
CA1	-0.42 ± 0.267	0.386 ± 0.15	0.806	0.013
CA2	-0.54 ± 0.054	-0.381 ± 0.126	0.159	0.494
CA3	-0.785 ± 0.06	-0.488 ± 0.075	0.296	0.048
CA5	-0.06 ± 0.297	0.992 ± 0.365	1.052	0.064
all	-0.451 ± 0.168	0.127 ± 0.179	0.578	0.03

Table 4: Results for Cognitive Indoor Play with Trained Dyads (Changed Weights)

Trained				
CA	**Pre**	**Post**	**Change**	p
CA1	0.338 ± 0.128	1.001 ± 0.126	0.663	0.006
CA2	0.721 ± 0.194	1.005 ± 0.177	0.2284	0.406
CA3	-0.131 ± 0.114	0.166 ± 0.085	0.298	0.09
CA5	2.158 ± 0.148	2.09 ± 0.171	-0.068	0.79
all	0.771 ± 0.146	1.066 ± 0.14	0.294	0.62

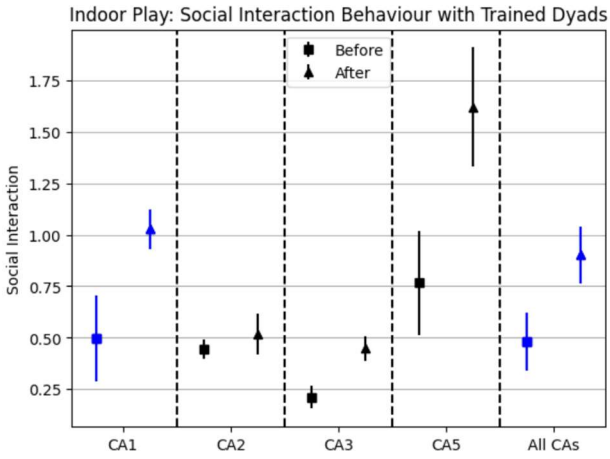


Figure 11: Original Social Indoor Play with Trained Dyads.

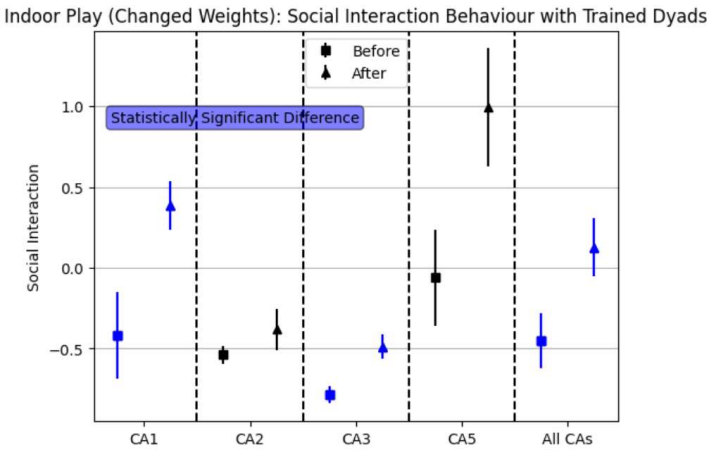


Figure 12: New weights – Social Indoor Play with Trained Dyads.

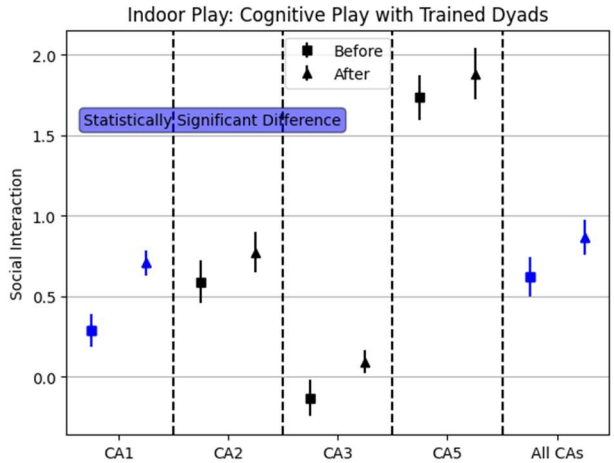


Figure 13: Original Cognitive Indoor Play with Trained Dyads.

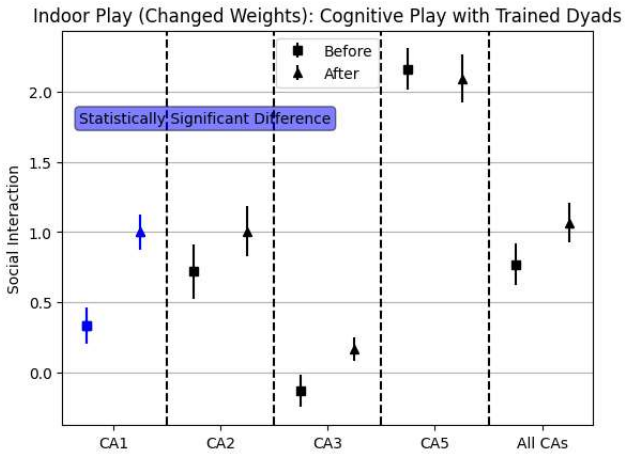


Figure 14: New weights – Cognitive Indoor Play with Trained Dyads.

- The scores for the original and new weights were also graphed together to demonstrate the change.
- Colour was used to differentiate between the original and new weights.

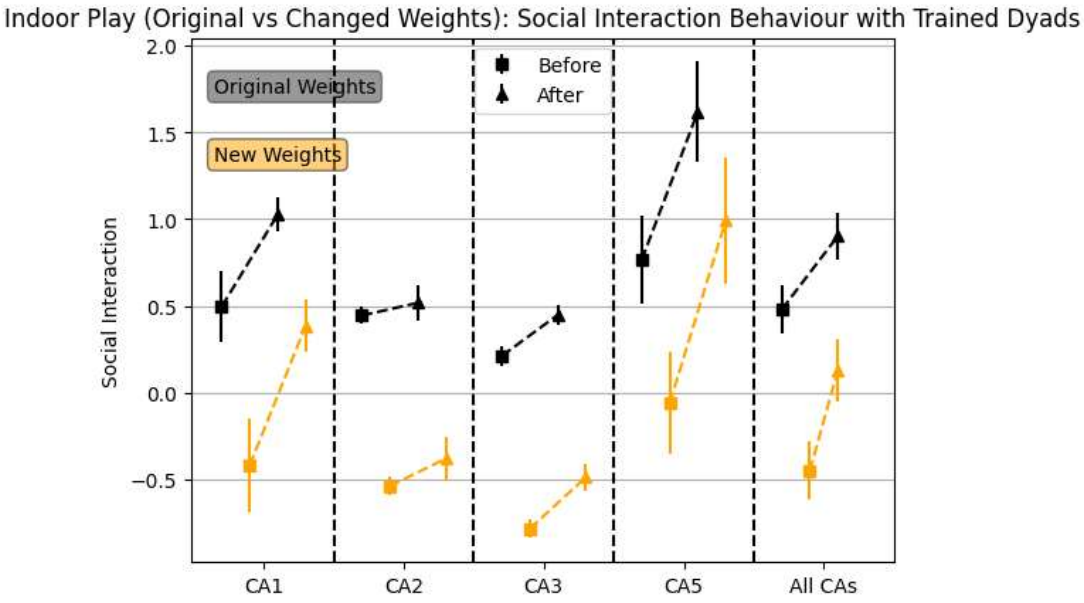


Figure 15: Change in social interaction score between original and new weighting for Social Indoor Play with Trained Dyads.

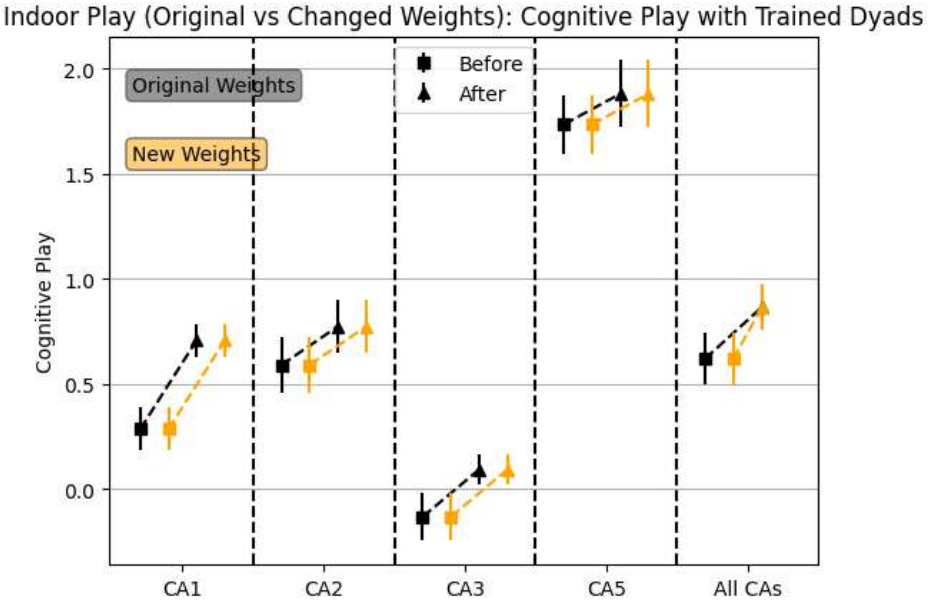


Figure 16: Change in cognitive play score between original and new weighting for Cognitive Indoor Play with Trained Dyads.

- Social interaction and cognitive play were also placed into one graph.
- To differentiate between the error bar graph with the All CAs score and the vertical scatter plot individual scores, the All CAs score was made semi-transparent with the individual scores placed in front.
    - However, this made the semi-transparent markers more difficult to see – particularly the orange colour although adding a black border slightly improved its visibility .

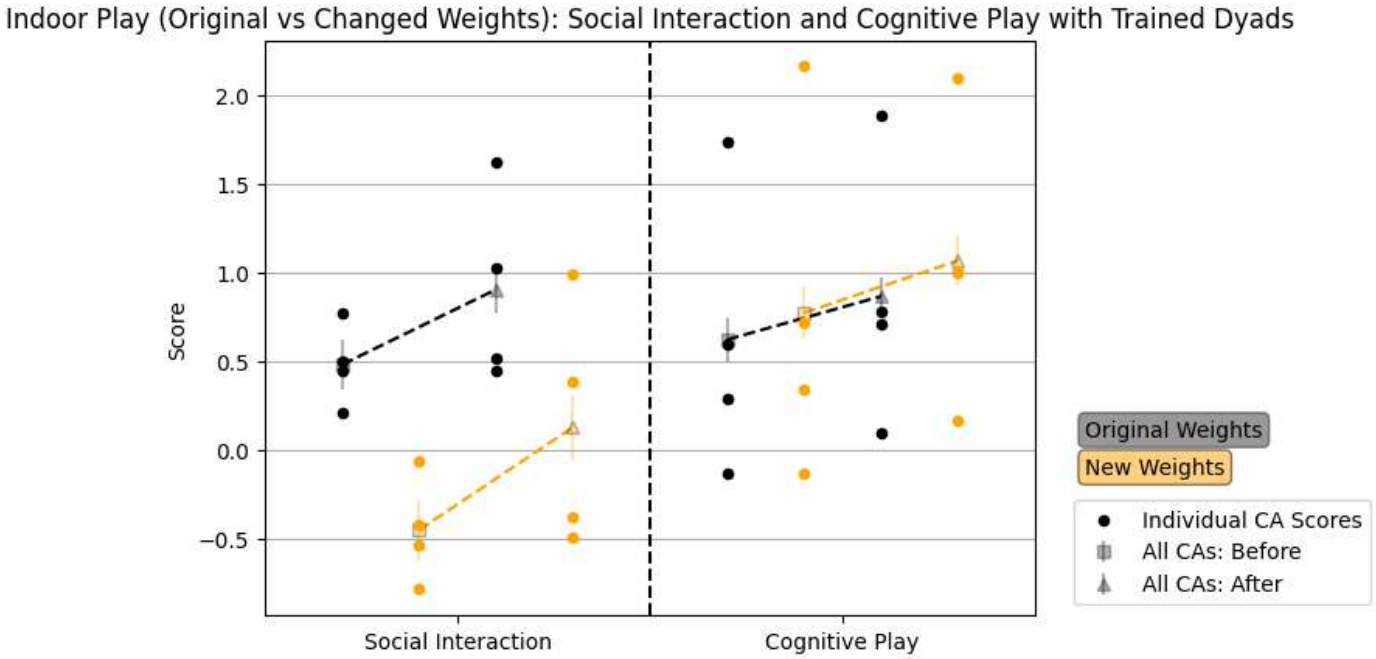


Figure 17: Change in social and cognitive scores between original and new weighting for Indoor Play with Trained Dyads.

GRAPHING A LINEAR TREND:

- Set x-axis as ‘before-training’ and y-axis as ‘after-training’.
- Plotted both x-error bars and y-error bars in respect to the before-training and after-training scores.
- Demonstrates a linear trend, which suggests there’s a relationship between before and after training such that the improvement between each CA and for all CAs is similar enough to produce a linear relationship.
- Added residuals which appears to reasonable as they’re mostly randomly distributed (scattered) around y = 0.

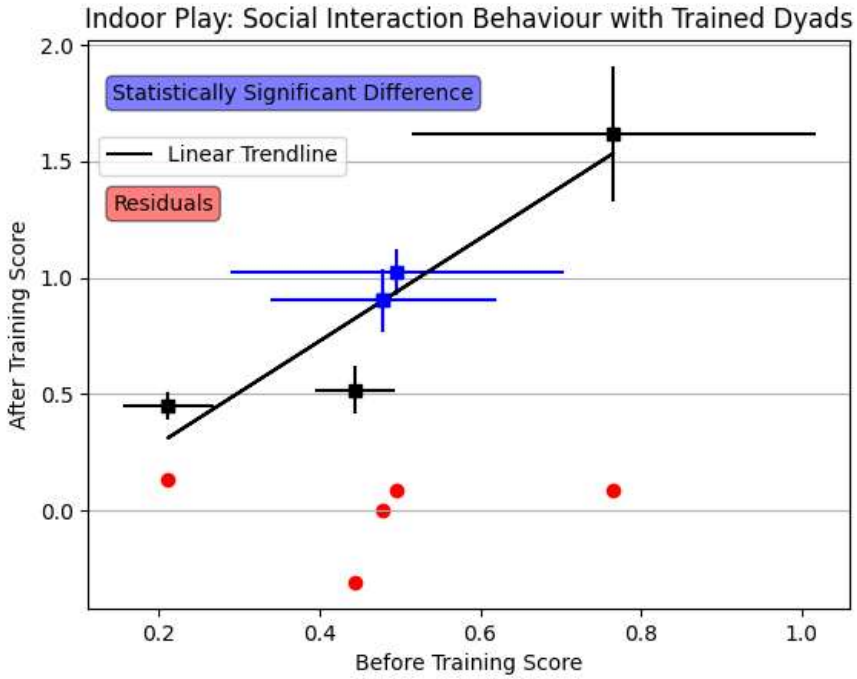
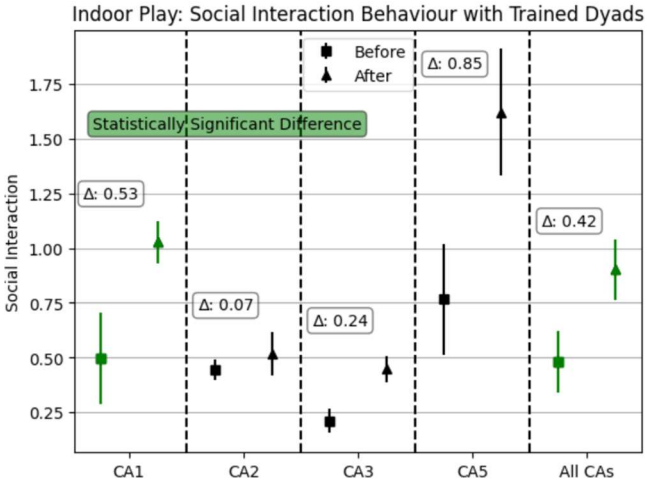


Figure 18: Linear relationship and residual plot relating “Before” and “After” training scores for Social Indoor Play with Trained Dyads.

APPENDIX:

APPENDIX 1: Green markers to symbolise statistical significance.



APPENDIX 2: Black background graph