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Descriptive & Inferential Analysis of a Jungian Sandplay VR Project

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1 Abstract

1.1 Aim and rationale

Data from a study are presented that investigated the effect of Jungian Sandplay therapy, conducted in a virtual reality environment, on psychotherapy patients undergoing treatment for PTSD. To test the effectiveness of different types of CBT treatment on PTSD, including that of VR treatment with static and animated model content.

1.2 Participants and setting

The experiment included a random sample of 150 young adult patients aged 18-25 years old with PTSD, evenly split between male and female. From the information provided, therapy was delivered by a therapist and with therapist-led ratings included it can be concluded that the experiment was conducted in a controlled and standardised manner.

For this analysis, only the difference between the animated VR group and control group were examined with 100 patients in scope.

1.3 Experiment design

It is unclear though whether the experiment was designed to control for potential confounders, and in particular, the fact that PTSD can reduce naturally without intervention (especially over such as long period such as the 12 weeks the experiment ran) and whether the patients benefited from any other support (i.e. it is common for those who have PTSD to take medication, such as anti-depressants which could imapct results).

From a design perspective, the experiment can be deemed as reliable since we have a randomised controlled trial where participants within a pre-determined criteria (young adults aged 18-25 years old) which were sourced using random sampling and randomly assignment to one of three test groups (1 control group and 2 different types of VR).

1.4 Results gathering

Analysis was focused on the difference between the OR (therapist observer rated) pre and post therapy scores opposed to the self observed results due to reliability and bias concerns. Sample data was loaded, inspected, cleaned, filtered and grouped before being able to perform calculations and carry out statistical tests.

1.5 Major findings

A Student's t-test performed yielded a p-value of 0.511 indicating a null hypothesis that animated VR Jungian Sandplay therapy does not have a greater effect on PTSD than traditional CBT Jungian Sandplay therapy.

1.6 Findings/implications

This investigation found no reason to suggest that Jungian Sandplay therapy in VR with animated model content yielded improved PTSD results as compared to that of traditional Jungian Sandplay therapy without the use of VR.

It is important to keep in mind that the above hypothesis is a prediction and not a definitive statement about the relationship between the VR treatment and reduced PTSD, but rather a starting point for further investigation where more information is needed.

Whilst the data meets the assumptions required for a statistical test, it should also be noted that the experiment information available limits the reliability of findings. Specifically, the age of each participant (i.e. there maybe additional influence of age), the amount of time since diagnosis (since both HSE and Mayo Clinic advise that some PTSD can naturally reduce over time), whether the patient is receiving any potentially conflicting treatment (i.e. PTSD medication) and the time of observation (noting that observations are recorded at the start and end of each day which is not recorded) can impact the results and the reliability of the experiment which can not be validated at this time.

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2 Introduction

2.1 Topic and context

According to the HSE and Mayo Clinic (2022) Post-traumatic stress disorder (PTSD) is a mental health condition that is triggered by a terrifying event — either experiencing it or witnessing it. Symptoms may include flashbacks, nightmares and severe anxiety, as well as uncontrollable thoughts about the event (Mayo Clinic, 2022). PTSD symptoms can be physical and/ or emotional and can vary over time or vary from person to person (with or without treatment).

Treatment for PTSD can vary between psychological therapies (such as cognitive behavioural therapy - CBT) and medication (such as antidepressants). This study will only focus on the difference between traditional pyschological therapy (CBT) and new VR versions (animated) of a Jungian Sandplay (a therapeutic method that uses sand, miniature objects, and image making within the context of the psychology of Carl Jung (Dooley, 2018).

2.2 Rationale

There are several methods employed to assess patient PTSD including observer-rated (OR), self- reported (CPSS), parental reported, and physiological measurements however only OR pre and post scores are used in this analysis due to reliability concerns of self recorded data outside a controlled and standardised manner which is essential for a robust experiment. Also note that specific focus will be applied on the variance between the pre and post scores (impact).

To focus analysis, two test groups were compared, specifically the animated VR therapy group of 50 patients against the control group of 50 patients who received traditional cognitive behavioural therapy.

2.3 Hypothesis

A null hypothesis is that animated VR therapy does not have a greater effect on PTSD than traditional CBT therapy, while a alternative hypothesis is that animated VR therapy has a greater positive effect on PTSD as compared to traditional pyshchological therapy.

3 Method

It is unclear though whether the experiment was designed to control for potential confounders, and in particular, the fact that PTSD can reduce naturally without intervention (especially over such as long period such as the 12 weeks the experiment ran) and whether the patients benefited from any other support (i.e. it is common for those who have PTSD to take medication, such as anti-depressants which could impact results).

From a design perspective, the experiment can be deemed as reliable since we have a randomised controlled trial where participants within a pre-determined criteria (young adults aged 18-25 years old) which were sourced using random sampling and randomly assignment to one of three test groups (1 control group and 2 different types of VR).

3.1 Participants

The experiment included a random sample of 150 young adult patients aged 18-25 years old with PTSD, evenly split between male and female. Note that it is unclear according to the information provided why young adults were specifically selected in this experiment however research does indicate that PTSD does impact young adult males (aged 18-24 years old) the most so this audience does represent the highest impacted population.

During that time the patients either underwent traditional CBT or the new VR therapy, it is clear that the delivery of the VR experience was consistent through 12 weeks of 50 minutes treatment per week with a therapist therefore it is adequately assumed that delivery was consistent and controlled.

3.2 Design

There are a few important factors that should be considered when conducting this experiment which has not been explicitly mentioned so must be considered and noted as it impacts the reliability of analysis and results.

Firstly, it is important to ensure that the study is conducted in a controlled and standardised manner. This means that the sample of patients should be selected using a random sampling method, and the groups should be of equal size to avoid any potential bias. From the information provided, since an appropriate random sampling approach has been followed, this is deemed to be appropriate and reliable however it should be noted that we have no information regarding other treatment which the patients could be involved with (since all patients have diagnosed PTSD, treatment is likely) which can directly impact the reliability of these results.

Second, studies like this should be designed to control for potential confounders, such as the patient's age, gender, and any other factors that could affect the outcome of the experiment. Gender and age is controlled within sampling which is sufficient however additional information on potentially conflicting treatment (i.e. mediciation) is not mentioned. Within the data, whilst gender is recorded, information on specific age and time of observation (i.e. start of end of day) which can impact results.

Third, it is important that this study should use valid and reliable measures to assess the patients' PTSD levels, both at the start and end of the study therefore all self recorded (CPSS) results have been discounted since they are self reported and uncontrolled. Focusing analysis on the observer rated results (OR) will help ensure that the results of the study are accurate and unbiased so they can be compared across the different test groups.

Fourth, it should be noted that it is important to ensure that the therapists administering the treatment are trained and experienced in using the VR app, as well as in providing traditional CBT which has not been validated within the information provided. It is assumed that all patients are receiving high-quality, consistent treatment so that any differences in outcomes between the groups can be attributed to the difference in treatment type.

Finally, the study should include a sufficient number of patients to provide statistical power and to ensure that the results are statistically significant. It has been deemed that the 150 patient population (50 per treatment type) is sufficient for this analysis and will help ensure that any observed differences between the groups can be confidently attributed to the VR app rather than to chance.

3.3 Materials

Based on the information provided, we know that all test groups underwent 12 weeks of treatment for 50 minutes per week with a therapist with the VR test group receiving a 'quality' version of the VR app. No other information is available about the material used for therapy or results gathering other than that a standardised scale was used with a range of 0 to 10.

3.4 Procedure

Before being able to perform calculations and carry out statistical tests on our data, we need to load, inspect, clean, filter and group it.

3.4.1 Load Data

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3.4.2 Inspect Data Structure

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Study Data

X	gender	test_group	pre_trial_cpss	post_trial_cpss	pre_trial_or	post_trial_or
1	Male	Static	5.99	5.41	6.25	5.27
2	Male	Static	4.69	4.91	5.01	4.76
3	Male	Static	6.94	5.63	6.80	5.63
4	Male	Static	7.49	5.38	7.83	5.49
5	Male	Static	6.81	6.96	6.56	7.07
6	Male	Static	7.89	4.95	7.93	4.92
7	Male	Static	6.83	5.29	6.30	5.12
8	Male	Static	6.89	4.41	6.66	4.57
9	Male	Static	6.78	3.34	7.08	3.19
10	Male	Static	6.35	5.54	6.11	5.64
11	Male	Static	5.78	6.36	5.97	6.58
12	Male	Static	6.59	6.08	6.34	6.20
13	Male	Static	7.10	4.65	7.19	4.53
14	Male	Static	5.23	12.00	5.27	6.35
15	Male	Static	7.97	4.47	8.28	4.33
16	Male	Static	5.48	5.56	5.55	5.71
17	Male	Static	7.00	6.67	7.28	6.78
18	Male	Static	6.09	6.68	6.12	6.92
19	Male	Static	5.78	5.88	5.26	5.89
20	Male	Static	5.25	5.13	4.77	4.91

X	gender	test_group	pre_trial_cpss	post_trial_cpss	pre_trial_or	post_trial_or
21	Male	Static	7.75	4.64	7.34	4.42
22	Male	Static	6.71	5.64	7.02	5.43
23	Male	Static	7.91	3.68	7.85	3.92
24	Male	Static	5.42	6.15	5.91	6.34
25	Male	Static	6.02	3.53	5.70	3.49
26	Female	Static	5.77	5.02	5.55	5.21
27	Female	Static	6.31	5.77	5.94	5.86
28	Female	Static	6.27	5.72	6.16	5.65
29	Female	Static	5.99	5.32	6.46	5.39
30	Female	Static	6.56	6.11	6.18	6.09
31	Female	Static	4.71	3.55	4.23	3.40
32	Female	Static	4.75	3.61	5.06	3.59
33	Female	Static	6.63	6.21	6.78	6.03
34	Female	Static	5.85	5.13	6.04	5.24
35	Female	Static	6.79	6.43	6.90	6.30
36	Female	Static	4.02	2.60	4.58	2.63
37	Female	Static	5.91	5.22	6.35	5.39
38	Female	Static	6.60	6.16	6.89	5.92
39	Female	Static	6.23	5.66	6.59	5.73
40	Female	Static	4.95	3.88	4.92	4.06
41	Female	Static	7.44	7.33	7.84	7.21
42	Female		6.32	5.78	6.44	5.75
43	Female	Static	6.68	6.27	6.94	6.40
44	Female	Static	6.71	6.32	6.58	6.56
45	Female	Static	5.75	5.00	5.70	4.90
46	Female	Static	4.98	3.92	5.15	3.92
47	Female	Static	5.62	4.81	5.59	4.87
48	Female	Static	5.97	5.29	5.79	5.08

X	gender	test_group	pre_trial_cpss	post_trial_cpss	pre_trial_or	post_trial_or
49	Female	Static	7.72	7.73	7.66	7.85
50	Female	Static	5.09	4.07	4.71	4.08
51	Male	Control	4.27	4.92	3.77	5.08
52	Male	Control	5.65	6.19	5.91	6.00
53	Male	Control	5.21	5.83	4.99	5.69
54	Male	Control	6.57	7.26	6.36	7.06
55	Male	Control	6.19	4.36	6.69	4.25
56	Male	Control	7.52	5.13	7.52	4.94
57	Male	Control	4.42	5.12	4.64	5.30
58	Male	Control	4.99	6.29	5.13	6.34
59	Male	Control	6.66	5.89	6.73	5.99
60	Male	Control	5.48	5.41	5.50	5.29
61	Male	Control	5.97	5.71	5.96	5.55
62	Male	Control	6.27	5.56	6.67	5.33
63	Male	Control	5.58	4.50	6.07	4.71
64	mal	Control	4.94	4.43	4.76	4.20
65	Male	Control	6.68	6.23	7.13	6.17
66	Male	Control	6.01	6.65	5.99	6.79
67	Male	Control	6.69	4.72	6.38	4.89
68	Male	Control	7.19	5.27	7.29	5.42
69	Male	Control	5.39	5.41	5.67	5.31
70	Male	Control	7.00	5.71	7.21	5.88
71	Male	Control	6.30	4.93	6.60	4.80
72	Male	Control	3.71	4.94	3.50	4.87
73	Male	Control	5.61	5.02	5.05	4.82
74	Male	Control	6.78	6.93	6.22	6.73
75	Male	Control	5.99	5.07	5.44	4.93
76	Female	Control	4.79	3.66	4.47	3.87

X	gender	test_group	pre_trial_cpss	post_trial_cpss	pre_trial_or	post_trial_or
77	Female	Control	5.77	5.02	5.30	4.78
78	Female	Control	6.11	5.49	6.01	5.52
79	Female	Control	5.38	4.48	4.81	4.39
80	Female	Control	4.85	3.74	5.14	3.90
81	Female	Control	6.20	5.62	6.53	5.61
82	Female	Control	8.03	8.15	8.25	8.17
83	Female	Control	6.50	6.03	6.82	5.90
84	Female	Control	7.26	7.09	6.77	7.14
85	Female	Control	8.12	8.27	7.79	8.18
86	Female	Control	7.36	7.22	7.88	7.06
87	Female	Control	5.36	4.46	5.17	4.42
88	Female	Control	6.88	6.55	6.67	6.72
89	Female	Control	4.99	3.94	5.44	3.99
90	Female	Control	4.71	3.55	4.30	3.57
91	Female	Control	5.55	4.72	5.65	4.94
92	Female	Control	7.84	7.88	8.08	7.96
93	Female	Control	5.53	4.68	5.21	4.63
94	Female	Control	5.72	4.95	5.78	4.75
95	Female	Control	6.15	5.54	5.60	5.47
96	Female	Control	7.31	7.15	7.44	6.94
97	Female	Control	4.26	2.92	3.70	2.74
98	Female	Control	6.94	6.64	7.25	6.78
99	Female	Control	5.03	3.99	5.32	3.77
100	Female	Control	5.99	5.33	6.02	5.20
101	Male	Animated	6.63	5.40	6.90	5.44
102	Male	Animated	7.26	6.29	7.05	6.48
103	Male	Animated	6.39	7.40	5.87	7.54
104	Male	Animated	5.39	4.88	5.93	4.71

X	gender	test_group	pre_trial_cpss	post_trial_cpss	pre_trial_or	post_trial_or
105	Male	Animated	5.31	6.25	4.89	6.26
106	Male	Animated	6.34	5.04	6.06	5.27
107	Male	Animated	7.25	5.67	7.11	5.91
108	Male	Animated	4.26	6.03	4.67	5.78
109	Male	Animated	6.92	5.48	6.68	5.47
110	Male	Animated	5.53	6.92	5.90	6.69
111	Male	Animated	4.75	5.04	4.69	5.29
112	Male	Animated	4.24	6.60	4.73	6.49
113	Male	Animated	7.00	5.39	7.43	5.51
114	Male	Animated	6.48	5.75	6.52	5.62
115	Male	Animated	7.41	3.93	7.71	4.00
116	Male	Animated	6.62	6.74	6.32	6.71
117	Male	Animated	7.20	5.69	6.92	5.90
118	Male	Animated	6.60	5.63	6.51	5.56
119	Male	Animated	7.07	5.40	6.78	5.40
120	Male	Animated	7.66	5.96	7.66	5.82
121	Male	Animated	5.82	5.41	6.08	5.64
122	Male	Animated	6.68	6.22	6.89	6.08
123	Male	Animated	5.85	6.71	6.10	6.53
124	Male	Animated	5.09	5.81	5.34	5.63
125	Male	Animated	6.75	5.73	6.80	5.58
126	Female	Animated	7.24	7.05	6.95	7.15
127	Female	Animated	6.05	5.41	6.33	5.17
128	Female	Animated	5.33	4.41	5.39	4.51
129	Female	Animated	5.40	4.50	5.05	4.55
130	Female	Animated	4.68	3.51	4.90	3.60
131	Female	Animated	5.17	4.18	5.22	4.16
132	Female	Animated	5.65	4.85	6.01	4.82

X	gender	test_group	pre_trial_cpss	post_trial_cpss	pre_trial_or	post_trial_or
133	Female	Animated	4.28	2.96	4.10	3.12
134	Female	Animated	5.46	4.58	5.22	4.67
135	Female	Animated	5.34	4.42	5.09	4.56
136	Female	Animated	5.76	5.01	5.48	5.19
137	Female	Animated	6.67	6.27	7.07	6.29
138	Female	Animated	7.20	6.99	7.69	7.18
139	Female	Animated	6.28	5.72	6.49	5.82
140	Female	Animated	5.88	5.17	6.20	5.11
141	Female	Animated	5.72	4.94	6.17	5.09
142	Female	Animated	4.30	2.98	4.42	3.00
143	Female	Animated	5.21	4.25	5.33	4.21
144	Female	Animated	6.17	5.58	5.76	5.36
145	Female	Animated	5.05	4.02	4.74	3.89
146	Female	Animated	5.75	5.00	5.45	5.17
147	Female	Animated	4.93	3.86	5.30	3.76
148	Female	Animated	6.11	5.49	6.19	5.71
149	Female	Animated	6.27	5.71	6.35	5.93
150	Female	Animated	4.81	3.68	4.39	3.58

3.4.3 Data Cleaning and Filtering

There are three instances of error in the data:

- Row 14: post_trial_cpss has a value of 12 (test_group = Static)
- Row 42: test_group is missing value ‘Static’
- Row 64: gender has a value of ‘mal’

Our hypothesis is looking at the difference between pre_trial_or and post_trial_or scores for the Control and Animated groups only, not testing gender as a contributing factor, so as it turned out we can safely ignore the errors in the data as they do not form part of the filtered subset we are investigating.

CODE

```
## ── Attaching packages ─────────────────────────────────────── tidyverse 1.3.2 ──
## ✓ ggplot2 3.4.0      ✓ purrr   1.0.0
## ✓ tibble  3.1.8      ✓ dplyr   1.0.10
## ✓ tidyr   1.2.1      ✓ stringr 1.5.0
## ✓ readr   2.1.3      ✓ forcats 0.5.2
## ── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
```

CODE

3.4.3.1 Filtered Subset

CODE

```
##     test_group pre_trial_or post_trial_or trial_or_diff
## 1      Control         3.77          5.08          1.31
## 2      Control         5.91          6.00          0.09
## 3      Control         4.99          5.69          0.70
## 4      Control         6.36          7.06          0.70
## 5      Control         6.69          4.25         -2.44
## 6      Control         7.52          4.94         -2.58
## 7      Control         4.64          5.30          0.66
## 8      Control         5.13          6.34          1.21
## 9      Control         6.73          5.99         -0.74
## 10     Control         5.50          5.29         -0.21
## 11     Control         5.96          5.55         -0.41
## 12     Control         6.67          5.33         -1.34
## 13     Control         6.07          4.71         -1.36
## 14     Control         4.76          4.20         -0.56
## 15     Control         7.13          6.17         -0.96
## 16     Control         5.99          6.79          0.80
## 17     Control         6.38          4.89         -1.49
## 18     Control         7.29          5.42         -1.87
## 19     Control         5.67          5.31         -0.36
## 20     Control         7.21          5.88         -1.33
## 21     Control         6.60          4.80         -1.80
## 22     Control         3.50          4.87          1.37
## 23     Control         5.05          4.82         -0.23
## 24     Control         6.22          6.73          0.51
## 25     Control         5.44          4.93         -0.51
## 26     Control         4.47          3.87         -0.60
## 27     Control         5.30          4.78         -0.52
## 28     Control         6.01          5.52         -0.49
## 29     Control         4.81          4.39         -0.42
## 30     Control         5.14          3.90         -1.24
## 31     Control         6.53          5.61         -0.92
## 32     Control         8.25          8.17         -0.08
## 33     Control         6.82          5.90         -0.92
## 34     Control         6.77          7.14          0.37
## 35     Control         7.79          8.18          0.39
## 36     Control         7.88          7.06         -0.82
## 37     Control         5.17          4.42         -0.75
## 38     Control         6.67          6.72          0.05
## 39     Control         5.44          3.99         -1.45
## 40     Control         4.30          3.57         -0.73
## 41     Control         5.65          4.94         -0.71
## 42     Control         8.08          7.96         -0.12
## 43     Control         5.21          4.63         -0.58
## 44     Control         5.78          4.75         -1.03
## 45     Control         5.60          5.47         -0.13
```

```
## 46     Control         7.44          6.94         -0.50
## 47     Control         3.70          2.74         -0.96
## 48     Control         7.25          6.78         -0.47
## 49     Control         5.32          3.77         -1.55
## 50     Control         6.02          5.20         -0.82
## 51    Animated         6.90          5.44         -1.46
## 52    Animated         7.05          6.48         -0.57
## 53    Animated         5.87          7.54          1.67
## 54    Animated         5.93          4.71         -1.22
## 55    Animated         4.89          6.26          1.37
## 56    Animated         6.06          5.27         -0.79
## 57    Animated         7.11          5.91         -1.20
## 58    Animated         4.67          5.78          1.11
## 59    Animated         6.68          5.47         -1.21
## 60    Animated         5.90          6.69          0.79
## 61    Animated         4.69          5.29          0.60
## 62    Animated         4.73          6.49          1.76
## 63    Animated         7.43          5.51         -1.92
## 64    Animated         6.52          5.62         -0.90
## 65    Animated         7.71          4.00         -3.71
## 66    Animated         6.32          6.71          0.39
## 67    Animated         6.92          5.90         -1.02
## 68    Animated         6.51          5.56         -0.95
## 69    Animated         6.78          5.40         -1.38
## 70    Animated         7.66          5.82         -1.84
## 71    Animated         6.08          5.64         -0.44
## 72    Animated         6.89          6.08         -0.81
## 73    Animated         6.10          6.53          0.43
## 74    Animated         5.34          5.63          0.29
## 75    Animated         6.80          5.58         -1.22
## 76    Animated         6.95          7.15          0.20
## 77    Animated         6.33          5.17         -1.16
## 78    Animated         5.39          4.51         -0.88
## 79    Animated         5.05          4.55         -0.50
## 80    Animated         4.90          3.60         -1.30
## 81    Animated         5.22          4.16         -1.06
## 82    Animated         6.01          4.82         -1.19
## 83    Animated         4.10          3.12         -0.98
## 84    Animated         5.22          4.67         -0.55
## 85    Animated         5.09          4.56         -0.53
## 86    Animated         5.48          5.19         -0.29
## 87    Animated         7.07          6.29         -0.78
## 88    Animated         7.69          7.18         -0.51
## 89    Animated         6.49          5.82         -0.67
## 90    Animated         6.20          5.11         -1.09
## 91    Animated         6.17          5.09         -1.08
## 92    Animated         4.42          3.00         -1.42
```

```
## 93    Animated         5.33          4.21         -1.12
## 94    Animated         5.76          5.36         -0.40
## 95    Animated         4.74          3.89         -0.85
## 96    Animated         5.45          5.17         -0.28
## 97    Animated         5.30          3.76         -1.54
## 98    Animated         6.19          5.71         -0.48
## 99    Animated         6.35          5.93         -0.42
## 100   Animated         4.39          3.58         -0.81
```

CODE

```
##   [1] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [13] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [25] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [37] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [49] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [61] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [73] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [85] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [97] FALSE FALSE FALSE FALSE
```

CODE

```
##   test_group  n
## 1   Animated 50
## 2    Control 50
```

CODE

```
## [1] 5.9741
```

CODE

```
## [1] 5.3965
```

CODE

```
## [1] -0.5776
```

CODE

```
## [1] test_group    pre_trial_or  post_trial_or trial_or_diff
## <0 rows> (or 0-length row.names)
```

CODE

Filtered Data required for Hypothesis Testing

test_group	pre_trial_or	post_trial_or	trial_or_diff

test_group	pre_trial_or	post_trial_or	trial_or_diff
Control	3.77	5.08	1.31
Control	5.91	6.00	0.09
Control	4.99	5.69	0.70
Control	6.36	7.06	0.70
Control	6.69	4.25	-2.44
Control	7.52	4.94	-2.58
Control	4.64	5.30	0.66
Control	5.13	6.34	1.21
Control	6.73	5.99	-0.74
Control	5.50	5.29	-0.21
Control	5.96	5.55	-0.41
Control	6.67	5.33	-1.34
Control	6.07	4.71	-1.36
Control	4.76	4.20	-0.56
Control	7.13	6.17	-0.96
Control	5.99	6.79	0.80
Control	6.38	4.89	-1.49
Control	7.29	5.42	-1.87
Control	5.67	5.31	-0.36
Control	7.21	5.88	-1.33
Control	6.60	4.80	-1.80
Control	3.50	4.87	1.37
Control	5.05	4.82	-0.23
Control	6.22	6.73	0.51
Control	5.44	4.93	-0.51
Control	4.47	3.87	-0.60
Control	5.30	4.78	-0.52
Control	6.01	5.52	-0.49

test_group	pre_trial_or	post_trial_or	trial_or_diff
Control	4.81	4.39	-0.42
Control	5.14	3.90	-1.24
Control	6.53	5.61	-0.92
Control	8.25	8.17	-0.08
Control	6.82	5.90	-0.92
Control	6.77	7.14	0.37
Control	7.79	8.18	0.39
Control	7.88	7.06	-0.82
Control	5.17	4.42	-0.75
Control	6.67	6.72	0.05
Control	5.44	3.99	-1.45
Control	4.30	3.57	-0.73
Control	5.65	4.94	-0.71
Control	8.08	7.96	-0.12
Control	5.21	4.63	-0.58
Control	5.78	4.75	-1.03
Control	5.60	5.47	-0.13
Control	7.44	6.94	-0.50
Control	3.70	2.74	-0.96
Control	7.25	6.78	-0.47
Control	5.32	3.77	-1.55
Control	6.02	5.20	-0.82
Animated	6.90	5.44	-1.46
Animated	7.05	6.48	-0.57
Animated	5.87	7.54	1.67
Animated	5.93	4.71	-1.22
Animated	4.89	6.26	1.37
Animated	6.06	5.27	-0.79

test_group	pre_trial_or	post_trial_or	trial_or_diff
Animated	7.11	5.91	-1.20
Animated	4.67	5.78	1.11
Animated	6.68	5.47	-1.21
Animated	5.90	6.69	0.79
Animated	4.69	5.29	0.60
Animated	4.73	6.49	1.76
Animated	7.43	5.51	-1.92
Animated	6.52	5.62	-0.90
Animated	7.71	4.00	-3.71
Animated	6.32	6.71	0.39
Animated	6.92	5.90	-1.02
Animated	6.51	5.56	-0.95
Animated	6.78	5.40	-1.38
Animated	7.66	5.82	-1.84
Animated	6.08	5.64	-0.44
Animated	6.89	6.08	-0.81
Animated	6.10	6.53	0.43
Animated	5.34	5.63	0.29
Animated	6.80	5.58	-1.22
Animated	6.95	7.15	0.20
Animated	6.33	5.17	-1.16
Animated	5.39	4.51	-0.88
Animated	5.05	4.55	-0.50
Animated	4.90	3.60	-1.30
Animated	5.22	4.16	-1.06
Animated	6.01	4.82	-1.19
Animated	4.10	3.12	-0.98
Animated	5.22	4.67	-0.55

test_group	pre_trial_or	post_trial_or	trial_or_diff
Animated	5.09	4.56	-0.53
Animated	5.48	5.19	-0.29
Animated	7.07	6.29	-0.78
Animated	7.69	7.18	-0.51
Animated	6.49	5.82	-0.67
Animated	6.20	5.11	-1.09
Animated	6.17	5.09	-1.08
Animated	4.42	3.00	-1.42
Animated	5.33	4.21	-1.12
Animated	5.76	5.36	-0.40
Animated	4.74	3.89	-0.85
Animated	5.45	5.17	-0.28
Animated	5.30	3.76	-1.54
Animated	6.19	5.71	-0.48
Animated	6.35	5.93	-0.42
Animated	4.39	3.58	-0.81

CODE

Control Group Subset

test_group	pre_trial_or	post_trial_or	trial_or_diff
Control	3.77	5.08	1.31
Control	5.91	6.00	0.09
Control	4.99	5.69	0.70
Control	6.36	7.06	0.70
Control	6.69	4.25	-2.44
Control	7.52	4.94	-2.58
Control	4.64	5.30	0.66
Control	5.13	6.34	1.21
Control	6.73	5.99	-0.74

test_group	pre_trial_or	post_trial_or	trial_or_diff
Control	5.50	5.29	-0.21
Control	5.96	5.55	-0.41
Control	6.67	5.33	-1.34
Control	6.07	4.71	-1.36
Control	4.76	4.20	-0.56
Control	7.13	6.17	-0.96
Control	5.99	6.79	0.80
Control	6.38	4.89	-1.49
Control	7.29	5.42	-1.87
Control	5.67	5.31	-0.36
Control	7.21	5.88	-1.33
Control	6.60	4.80	-1.80
Control	3.50	4.87	1.37
Control	5.05	4.82	-0.23
Control	6.22	6.73	0.51
Control	5.44	4.93	-0.51
Control	4.47	3.87	-0.60
Control	5.30	4.78	-0.52
Control	6.01	5.52	-0.49
Control	4.81	4.39	-0.42
Control	5.14	3.90	-1.24
Control	6.53	5.61	-0.92
Control	8.25	8.17	-0.08
Control	6.82	5.90	-0.92
Control	6.77	7.14	0.37
Control	7.79	8.18	0.39
Control	7.88	7.06	-0.82
Control	5.17	4.42	-0.75

test_group	pre_trial_or	post_trial_or	trial_or_diff
Control	6.67	6.72	0.05
Control	5.44	3.99	-1.45
Control	4.30	3.57	-0.73
Control	5.65	4.94	-0.71
Control	8.08	7.96	-0.12
Control	5.21	4.63	-0.58
Control	5.78	4.75	-1.03
Control	5.60	5.47	-0.13
Control	7.44	6.94	-0.50
Control	3.70	2.74	-0.96
Control	7.25	6.78	-0.47
Control	5.32	3.77	-1.55
Control	6.02	5.20	-0.82

CODE

Animated Group Subset

test_group	pre_trial_or	post_trial_or	trial_or_diff
Animated	6.90	5.44	-1.46
Animated	7.05	6.48	-0.57
Animated	5.87	7.54	1.67
Animated	5.93	4.71	-1.22
Animated	4.89	6.26	1.37
Animated	6.06	5.27	-0.79
Animated	7.11	5.91	-1.20
Animated	4.67	5.78	1.11
Animated	6.68	5.47	-1.21
Animated	5.90	6.69	0.79
Animated	4.69	5.29	0.60
Animated	4.73	6.49	1.76

test_group	pre_trial_or	post_trial_or	trial_or_diff
Animated	7.43	5.51	-1.92
Animated	6.52	5.62	-0.90
Animated	7.71	4.00	-3.71
Animated	6.32	6.71	0.39
Animated	6.92	5.90	-1.02
Animated	6.51	5.56	-0.95
Animated	6.78	5.40	-1.38
Animated	7.66	5.82	-1.84
Animated	6.08	5.64	-0.44
Animated	6.89	6.08	-0.81
Animated	6.10	6.53	0.43
Animated	5.34	5.63	0.29
Animated	6.80	5.58	-1.22
Animated	6.95	7.15	0.20
Animated	6.33	5.17	-1.16
Animated	5.39	4.51	-0.88
Animated	5.05	4.55	-0.50
Animated	4.90	3.60	-1.30
Animated	5.22	4.16	-1.06
Animated	6.01	4.82	-1.19
Animated	4.10	3.12	-0.98
Animated	5.22	4.67	-0.55
Animated	5.09	4.56	-0.53
Animated	5.48	5.19	-0.29
Animated	7.07	6.29	-0.78
Animated	7.69	7.18	-0.51
Animated	6.49	5.82	-0.67
Animated	6.20	5.11	-1.09

test_group	pre_trial_or	post_trial_or	trial_or_diff
Animated	6.17	5.09	-1.08
Animated	4.42	3.00	-1.42
Animated	5.33	4.21	-1.12
Animated	5.76	5.36	-0.40
Animated	4.74	3.89	-0.85
Animated	5.45	5.17	-0.28
Animated	5.30	3.76	-1.54
Animated	6.19	5.71	-0.48
Animated	6.35	5.93	-0.42
Animated	4.39	3.58	-0.81

4 Results

4.1 Descriptive statistics

4.1.1 Mean and Standard Deviation

CODE

The means and standard deviations of the difference between the pre and post trial observer rated scores for the control and animated groups are shown below:

control_or_diff: M = -0.52, SD = 0.88

animated_or_diff: M = -0.64, SD = 0.96

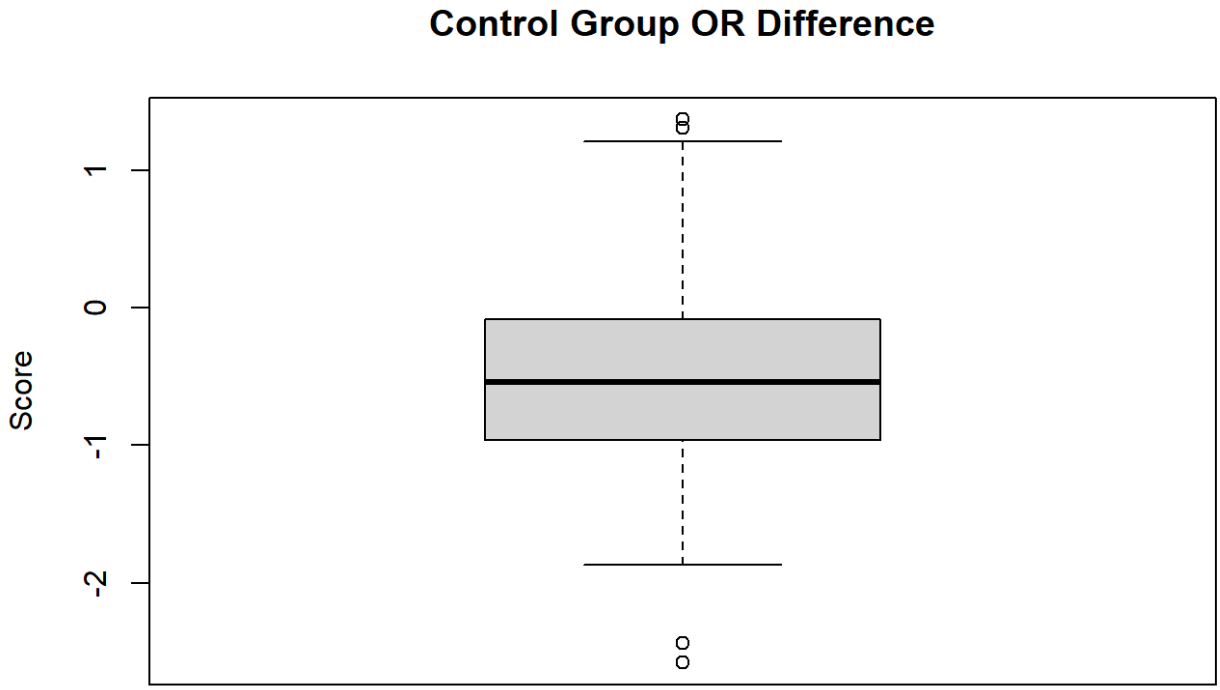
4.1.2 Data Summary

A summary of the data is shown below:

CODE

```
##   test_group         pre_trial_or   post_trial_or   trial_or_diff
##  Length:50          Min.   :3.500   Min.   :2.740   Min.   :-2.5800
##  Class :character   1st Qu.:5.180   1st Qu.:4.758   1st Qu.:-0.9600
##  Mode  :character   Median :5.975   Median :5.305   Median :-0.5400
##                     Mean   :5.972   Mean   :5.455   Mean   :-0.5168
##                     3rd Qu.:6.720   3rd Qu.:6.128   3rd Qu.:-0.0900
##                     Max.   :8.250   Max.   :8.180   Max.   : 1.3700
```

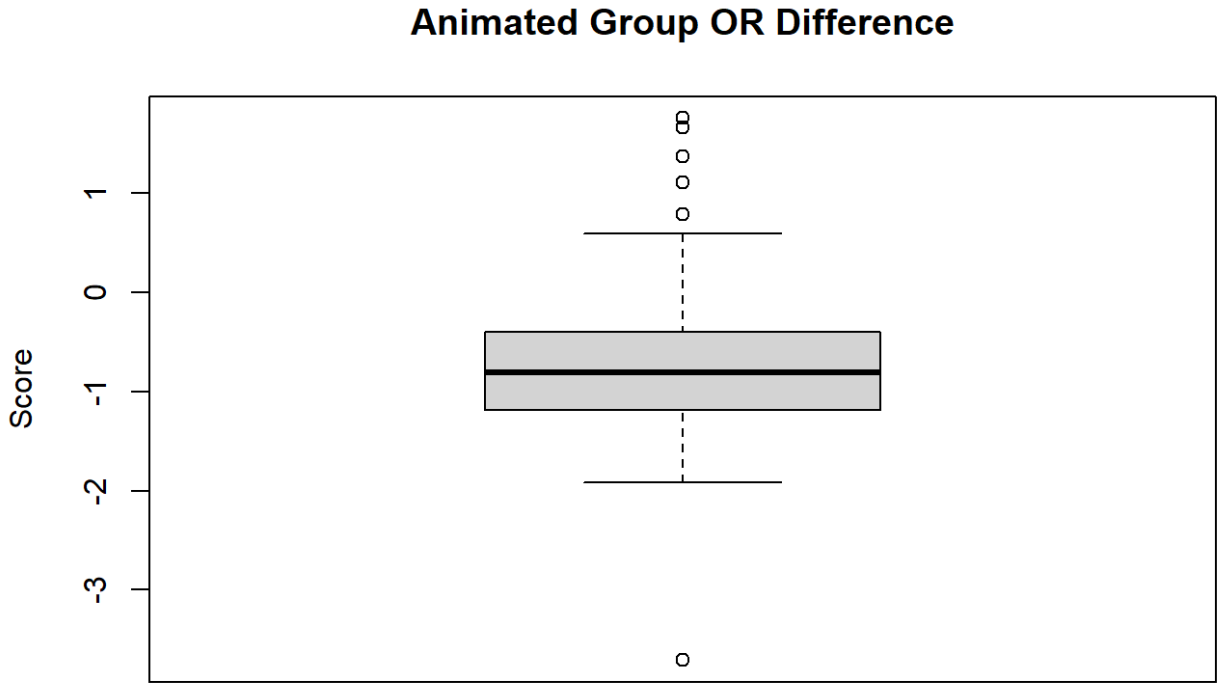
CODE



CODE

```
##   test_group         pre_trial_or   post_trial_or   trial_or_diff
##  Length:50          Min.   :4.100   Min.   :3.000   Min.   :-3.7100
##  Class :character   1st Qu.:5.240   1st Qu.:4.680   1st Qu.:-1.1825
##  Mode  :character   Median :6.070   Median :5.455   Median :-0.8100
##                     Mean   :5.977   Mean   :5.338   Mean   :-0.6384
##                     3rd Qu.:6.755   3rd Qu.:5.907   3rd Qu.:-0.4050
##                     Max.   :7.710   Max.   :7.540   Max.   : 1.7600
```

CODE



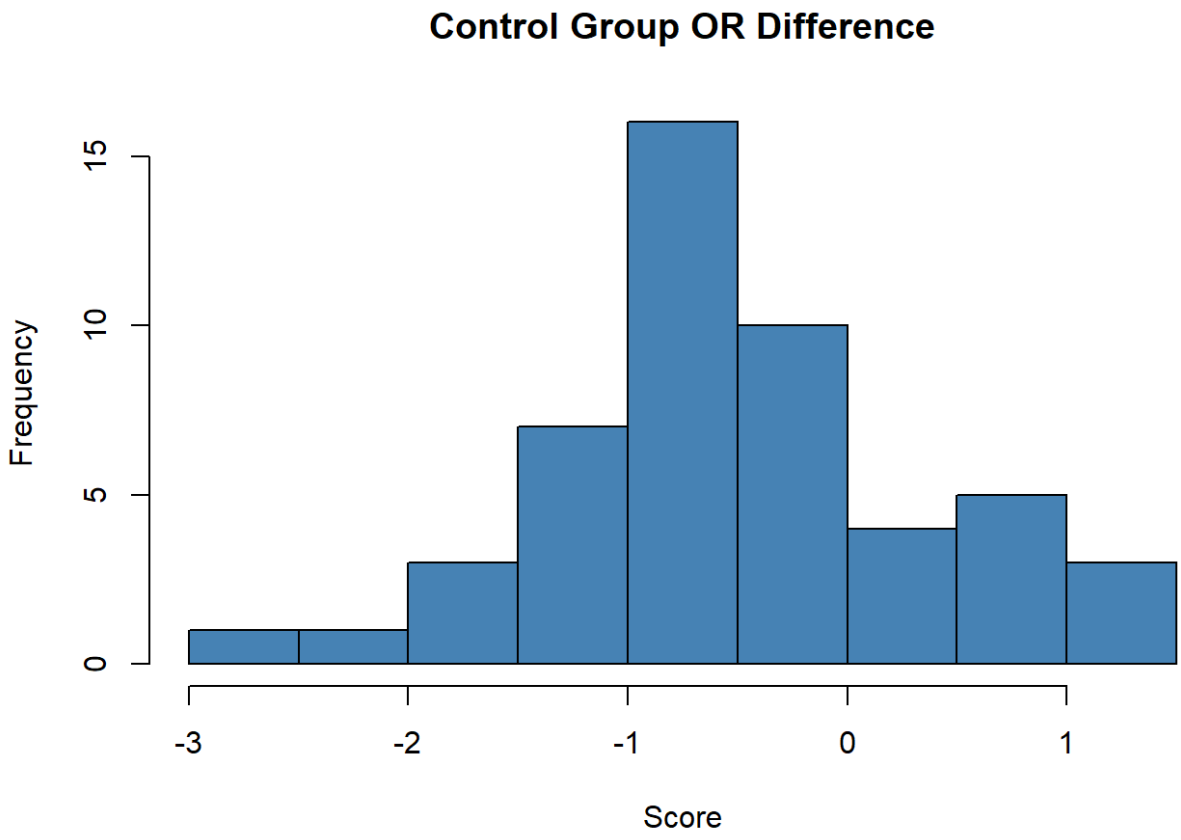
4.2 Inferential statistics

The inference and statistical tests that we are doing on our data make the assumption that the data are normally distributed. Thus the below tests are first carried out to check this assumption by testing for normality.

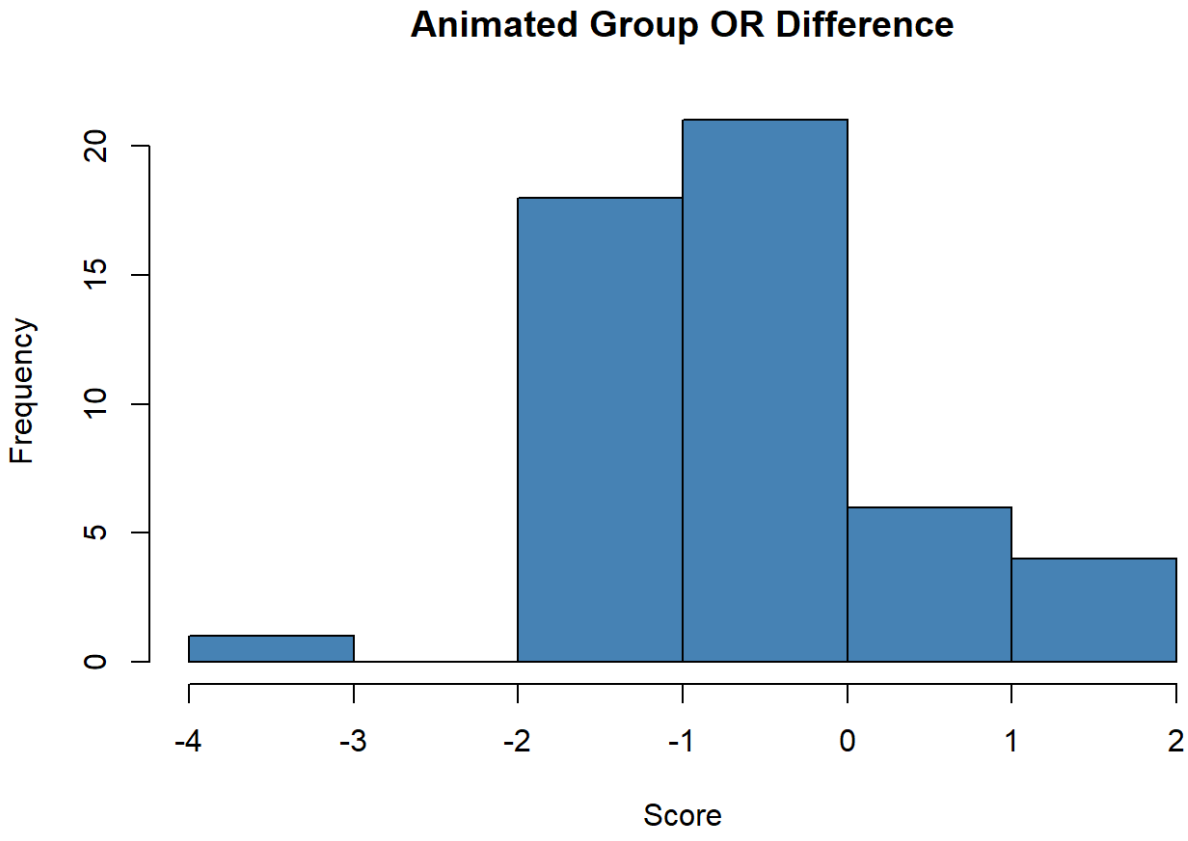
4.2.1 Testing for Normality

4.2.1.1 Method 1: Using Histogram / Density Plot

CODE


Control Group OR Difference
Frequency
0
5
10
15
-3
-2
-1
0
1
Score

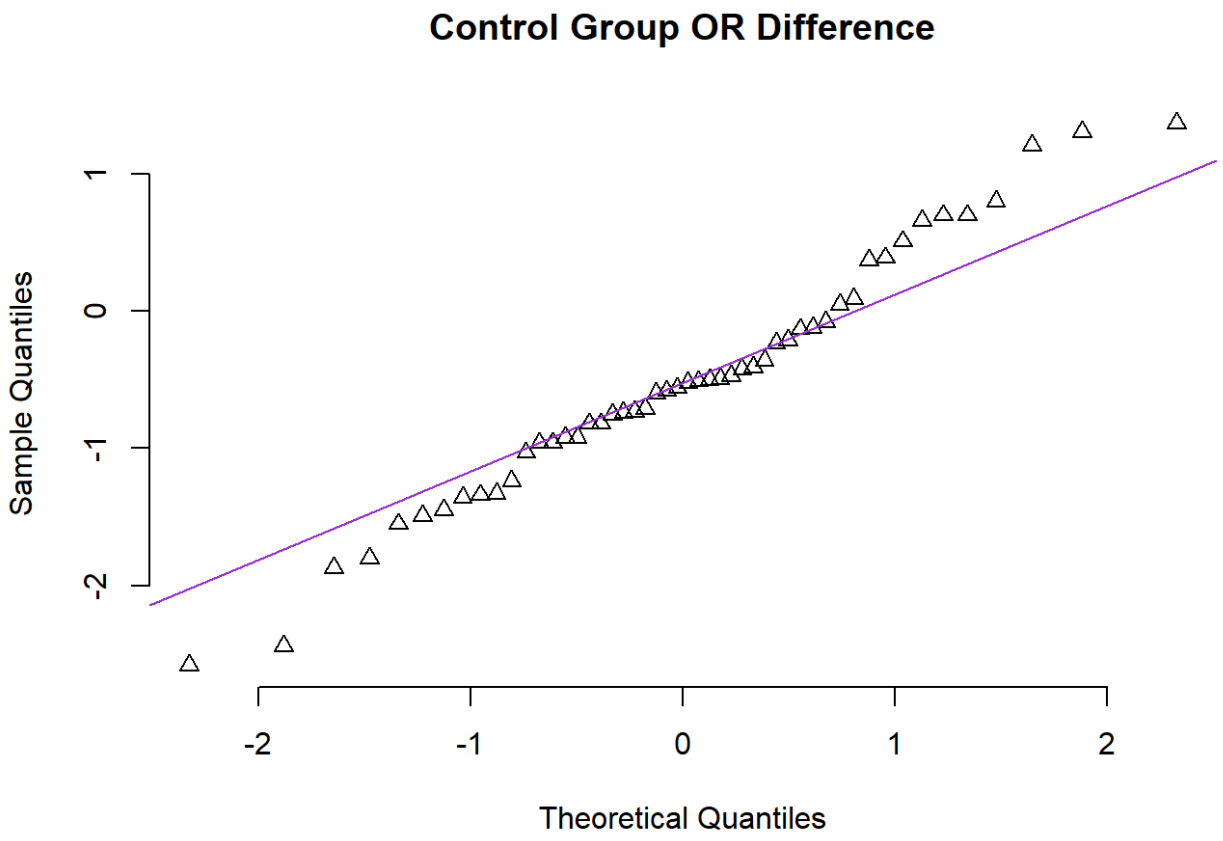
CODE


Animated Group OR Difference
Frequency
0
5
10
15
20
-4
-3
-2
-1
0
1
2
Score

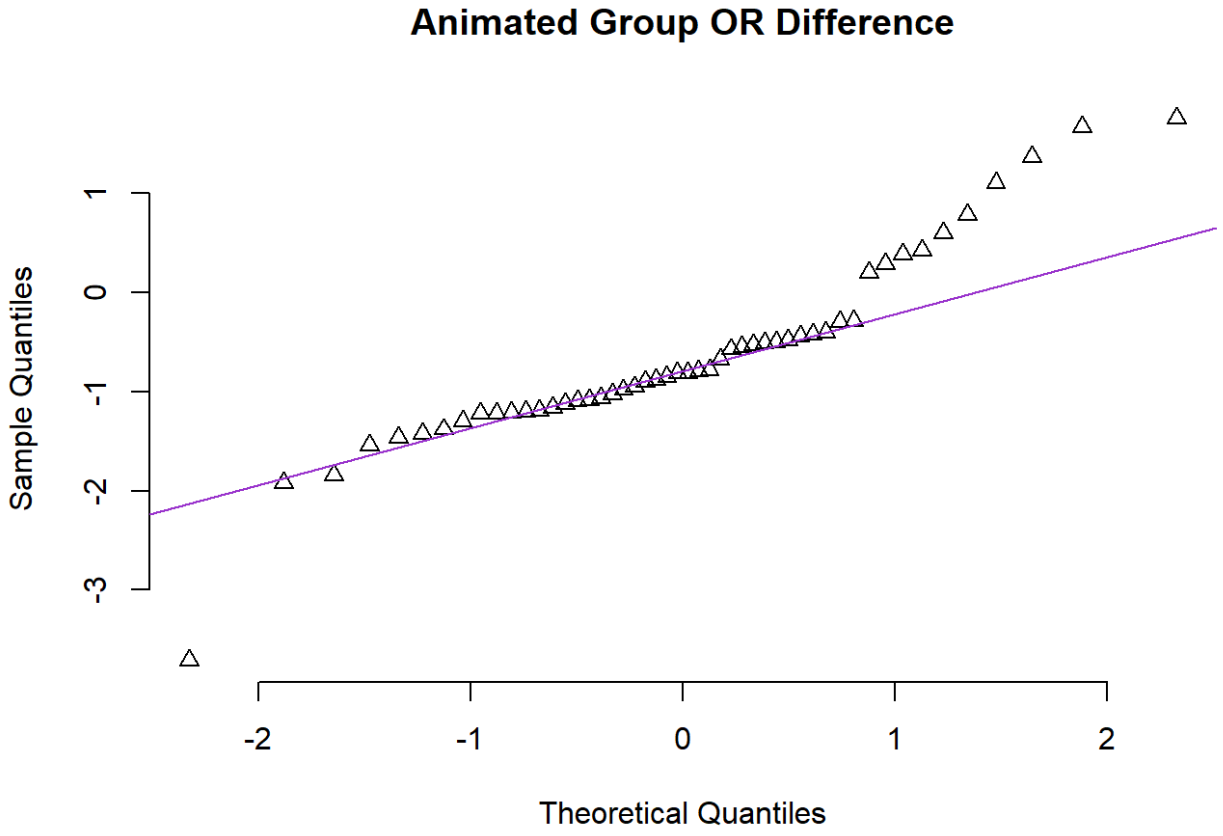
Both histograms above exhibit data that could be normally distributed as they are both roughly “bell-shaped” in nature, though the ‘Animated Group OR Difference’ histogram is slightly right skewed which indicates a few higher scoring outliers.

4.2.1.2 Method 2: Using Q-Q Plot

CODE



CODE



In both Q-Q plots above, the majority of the sample points roughly fall along the diagonal Q-Q line and thus give an indication that the data is normally distributed. However, as not all points fall exactly on the line we will continue testing to investigate further. Again we can see the high outliers in the 'Animated Group OR Difference' plot, with most points falling on the Q-Q line.

4.2.1.3 Method 3: Statistical Test: Shapiro-Wilk

The threshold for normality is 0.05 (5%). If the p-value is above the threshold then we can accept the data to be normally distributed.

CODE

```
##
##  Shapiro-Wilk normality test
##
## data:  subset_control$trial_or_diff
## W = 0.98098, p-value = 0.5941
```

A Shapiro-Wilk normality test was conducted on the trial_or_diff data of the Control group.
From the output obtained we can assume normality as the p-value (p = 0.5941) is greater than 0.05.

CODE

```
##
##  Shapiro-Wilk normality test
##
## data:  subset_animated$trial_or_diff
## W = 0.9159, p-value = 0.001682
```

A Shapiro-Wilk normality test was conducted on the trial_or_diff data of the Animated group.
From the output obtained we cannot assume normality as the p-value (p = 0.0017) is less than 0.05.

However, a Shapiro-Wilk in isolation does not guarantee normality or non-normality of data. Interestingly, when you look at the raw source sample data of the pre and post scores for the animated group (and not only the calculated difference between the two), both display Shapiro-Wilk results that indicate normality.

CODE

```
##
##  Shapiro-Wilk normality test
##
## data:  subset_animated$pre_trial_or
## W = 0.97466, p-value = 0.3541
```

CODE

```
##
##  Shapiro-Wilk normality test
##
## data:  subset_animated$post_trial_or
## W = 0.9822, p-value = 0.6476
```

Animated group: pre_trial_or p-value (p = 0.3541) is greater than 0.05.
Animated group: post_trial_or p-value (p = 0.6476) is greater than 0.05.

Looking at these results alongside the histogram and Q-Q plots, it is reasonable to say that the trial_or_diff data of the Animated group may be slightly non-normal with some positive skew on the right tail, but also that it is normal enough to be able to perform statistical t-tests.

4.3 Statistical tests

The Student's t-Test was performed to be able to determine whether to accept or reject the null hypothesis.

CODE

```
##
##  Welch Two Sample t-test
##
## data:  trial_or_diff by test_group
## t = -0.65977, df = 97.38, p-value = 0.511
## alternative hypothesis: true difference in means between group Animated and group Control
is not equal to 0
## 95 percent confidence interval:
##  -0.4873807  0.2441807
## sample estimates:
## mean in group Animated  mean in group Control
##                -0.6384                -0.5168
```

CODE

```
##
##  One Sample t-test
##
## data:  subset_control$trial_or_diff
## t = -4.1339, df = 49, p-value = 0.0001391
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.7680292 -0.2655708
## sample estimates:
## mean of x
##   -0.5168
```

CODE

```
##
##  One Sample t-test
##
## data:  subset_animated$trial_or_diff
## t = -4.714, df = 49, p-value = 2.047e-05
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.9105481 -0.3662519
## sample estimates:
## mean of x
##   -0.6384
```

The Student's t-test yielded a p-value of 0.511 is greater than 0.05 and indicates that the null hypothesis should not be rejected.

The 95% confidence interval for the mean of the difference in pre and post treatment score of the Control group is -0.77 to -0.27.

The 95% confidence interval for the mean of the difference in pre and post treatment score of the Animated group is -0.91 to -0.37.

---

5 Discussion

5.1 Findings

The findings from the analysis of the sample data as part of this investigation are listed below:

- The Control group (traditional CBT, no VR) experienced a reduction in observer rated PTSD scores with a mean of -0.52 and standard deviation of 0.88.
- The Animated group (animated model content, VR) also experienced a reduction in observer rated PTSD scores with a mean of -0.64 and standard deviation of 0.96.
- The sample data was found to exhibit that of a normally distributed data set by testing via the histogram plot, Q-Q plot and Shapiro-Wilk methods. Thus we could assume it to be normally distributed in order to be able to carry out the Student's t-test.
- A p-value of 0.511 from the Student's t-test is not very significant as the probability of seeing a difference between the mean scores of the Control and Animated groups is high. As the p-value is greater than 0.05, this means that the test results suggest that the data does not provide convincing evidence for the alternative hypothesis and that we should accept the null hypothesis as true. Thus we find that the difference between the means of the change in observed scores of the Control and Animated groups is zero, meaning that there is not a realised difference between traditional Jungian Sandplay therapy without VR and that of Jungian Sandplay therapy in VR with animated model content.

5.2 Limitations

We're not aware of any confounding variables in the data provided, however there could be limitations to the study to consider including natural improvements to PTSD without treatment and the impact of other PTSD treatments on the patients being assessed (i.e. medication).

---

6 References

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